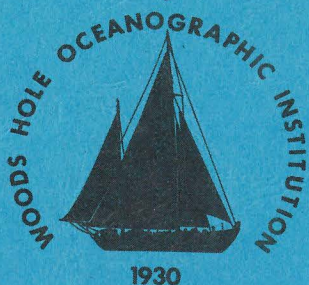


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CONSTRUCTION OF PARFLUX MARK II SEDIMENT TRAP; ENGINEERING REPORT

by

Susumu Honjo
and
John F. Connell

November 1979

TECHNICAL REPORT

*Prepared for the National Science Foundation
under Grants OCE 76-82063 and OCE 77-27004.*

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Approved for Distribution

John I. Ewing
John I. Ewing, Chairman
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CONSTRUCTION OF PARFLUX MARK II SEDIMENT TRAP; ENGINEERING REPORT

by

Susumu Honjo and John F. Connell

Abstract

A large, open ocean applicable sediment trap has been developed at the Woods Hole Oceanographic Institution in order to assess the fluxes of particles sinking through the deep water column, under the sponsorship of the National Science Foundation. PARFLUX Mark II trap, 1978-79 version for PARFLUX phase I program, has been successfully developed and has gathered much meaningful data. A trap opening is 1.5 m^2 and consists of 94 hexagonal buffer cells with the nominal form ratio of 2. Sediment particles are concentrated to the receiving cup located at the bottom of the funnel-shaped trap. Two types of receiving cups have been developed; a trap with Type S cup is open at both ends as it sinks to the designated depth. Twenty-four hours after the deployment the receiving cup moves into alignment with the funnel to store the sediment. At the end of deployment a spring mechanism activated by a quartz oscillator based electrical timer-release retracts the receiving cup, seals the collected sample and leave the funnel open at both ends while the trap ascends for recovery. Type C mechanism is installed with a shutter which seals the cup during recovery; this type involves a simple mechanism with less moving parts. Sodium azide/sodium chloride solution is diffused through a series of membrane filters to keep the cup contents in an aseptic condition. Since October 1976 to December 1979, we have deployed and recovered 24 traps successfully along with several moorings as deep as 5,600 m for as long as 112 days. This reports the engineering detail and lists the required parts to assist the construction, operation and maintenance of the PARFLUX Mark II sediment trap.

Introduction

The flux of particles through the oceanic water column, its quality and quantity, is important in understanding the processes of marine sedimentation. Indeed, marine flux studies have been receiving attention from many disciplines in recent years (e.g. Wiebe, 1976; Izeki, 1976; Gardner, 1977; Soutar et al., 1977; Bishop et al., 1978; Honjo, 1978; Spencer et al., 1978; Staresenic, 1978; Knauer et al., 1979).

Evidence has been found which suggests that there is efficient means of transport of particles, nutrients and man-made matter from the upper layer to the bottom in the pelagic water column (e.g. Osterberg et al., 1963; Schrader, 1971; Honjo, 1976; Elder and Fowler, 1977). Theoretical consideration of ocean particles (e.g. McCave, 1974) has shown that their size distribution may be described as an exponential function. In practice, ocean particles larger than 20 μ m are rare and have a low probability of occurrence in an open sea water sample (Smayda, 1970; Carder et al., 1971; Sheldon et al., 1972). However, despite their low abundance, the exponential increase in mass and sinking velocity with size shifts the predominant fraction of mass flux of settling particles to the large size range.

Collection of such large marine particles by ordinary means with water bottle casting is extremely inefficient because of their smaller standing stock and faster sinking rate. Intercepting sinking particles by deploying a receiver has been practiced for a long time in various aquatic environments.

In order to examine the sediment trap samples under diversified multi-disciplinary methods, it is desirable to collect large quantities. This is especially true for radiochemical measurements which often require sediment samples on the order of grams. However, the material flux is usually small in the open sea where the organic productivity is low and is far from the continent. Catchment of a large volume sample can be achieved by a larger aperture and/or longer exposure of a sediment trap. Both of these conditions are severely limited in the open sea by the size of traps and logistics of their deployment.

Our basic requirements for designing a sediment trap were: 1) hydrodynamically feasible design for widening the size spectrum of particles to be collected in the slow advective deep ocean layer; 2) ability to collect gram size sediment samples during one deployment; 3) traps must be constructed ruggedly to withstand rough sea conditions, but handled with standard deck equipments of average research vessels; 4) the material used should be able to resist corrosion and weakening for at least 18 consecutive months at any depth in the ocean;

and 5) in our particular case, metallic contact to the sediment should be avoided. A large, durable sediment trap has thus been developed under the code name of PARFLUX (Particulate Flux) to meet the above requirements under the sponsorship of the Oceanographic Section, National Science Foundation. Twelve traps have been manufactured and used to serve for a series of pelagic experiments.

We have deployed the traps along with several moorings at the deep ocean, as deep as 5,600 m deep, using many U.S. research vessels under various sea conditions. They were in water for up to 112 days per deployment. Some traps were redeployed immediately and experienced approximately 12 months of accumulative underwater exposure. We have successfully collected 24 samples from the Atlantic and the Pacific stations. After numerous improvements we are now convinced that a PARFLUX sediment trap is a useful oceanographic research tool. This report outlines the design of a PARFLUX Mark II. More details such as blue plans for each component as indicated in the parts list of this report can be supplied upon request. The results of scientific research on the collected samples have been published elsewhere (e.g. Honjo, 1978; Spencer et al., 1978; Honjo, 1980, in press).

Description of PARFLUX Mark II Sediment Trap

A PARFLUX Mark II sediment trap consists of three subsystems: 1) collector with honeycomb buffer (Figs. 1, 2, 5 and Plate 1); 2) a receiving cup and a closing mechanism including timer electronics (Figs. 3 and 6, Plates 2 and 3); and 3) a frame to house 1, 2 and buoyancy spheres (Figs. 2 and 5). The air weight of a sediment trap is 872 lb. and it is 30 lb. positively buoyant in 18°C seawater. Materials used for the construction of the trap were decided based on the results of an exposure experiment in various locations and depths in the deep Atlantic where an assortment of plastics, aluminum alloys and stainless steel were exposed for up to 18 months along a mooring taut line (Plate 4 and partly in Dexter, 1974).

Honeycomb Buffer and Funnel

The buffer has a 145 cm diameter opening and consists of 94 maximum packed hexagonal cells totalling 1.5 square meters (Fig. 1) and are made of 1/6" thick polyvinyl chloride (PVC) Trovidour^R sheet. Hexagonal cells are made by fitting PVC sheets which are bent in alternation of 120°, 180°, 240° and 180° (refer to Honjo's internal memorandum, April 29, 1976).

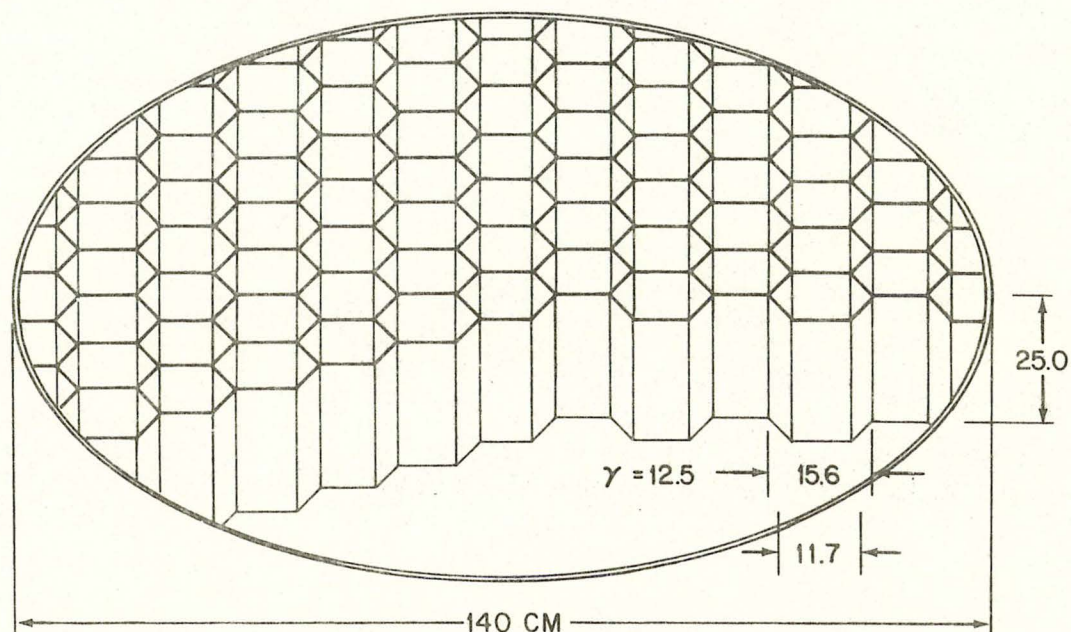


Fig. 1. Configuration of a buffer and hexagonal cells.

The buffer alternates the horizontal element of flow and corrects the trajectory of travelling particles toward the direction of gravity. Soutar et al. (1977) reported that the steady horizontal flow is inhibited at the depth equivalent to 20% of the width of a buffer cell when the form ratio of cells (diameter vs. depth of a cell) is sufficiently large.

The diameter of the circumscribed circle of a hexagon was 15.6 cm (11.7 cm for inscribed circle) (Fig. 1). The height of a cell was 25 cm (nominal form ratio: 2.0). The outer edge of a collector is tapered at 21 degrees in order to fit in the upper margin of the funnel.

The diameter of the upper opening (ID), lower opening (ID) of a collecting funnel were 146 cm and 10 cm, respectively. The height was 178 cm forming 42° frustrum angle. We used Trevodour^R linear PVC for funnel construction. A funnel shape was cut from 1.0 cm thick, 8'x8' polyvinyl chloride sheet stock and formed over a steel mold in a 120°C oven. The seams were then hot air welded. The upper and lower edges were cut and ground flat to accept the mounting plate. Then the funnel was annealed for a few days at 60°C. The seam that appears on the interior surface of a funnel was ground smooth and lapped by fine buffing. A sample of the buffed surface was checked under SEM for smoothness (Plate 4). Four channels made of 2 cm thick PVC were attached to the frustrum to mount the funnel assemblage to the frame via U-shaped tubings. A square plate to accept the receiving cup mechanism was welded to the bottom of the funnel and the lower end of the channels (Figs. 2 and 5).

Receiving Cup Mechanism

Two types of receiving cups have been developed for the PARFLUX Phase 1 experiment. Type C (a shutter insulates the receiving cup) was first developed mainly by Mr. Connell and successfully used during many of the Phase 1 experiments. Dr. W. Deuser developed the moving cup mechanism for his experiments (Deuser and Ross, in press) applying the PARFLUX trap. Mr. P. Sachs, assisted by Mr. D. LeBlanc, completed the engineering of the Type S mechanism which is now used as the standard PARFLUX instrumentation.

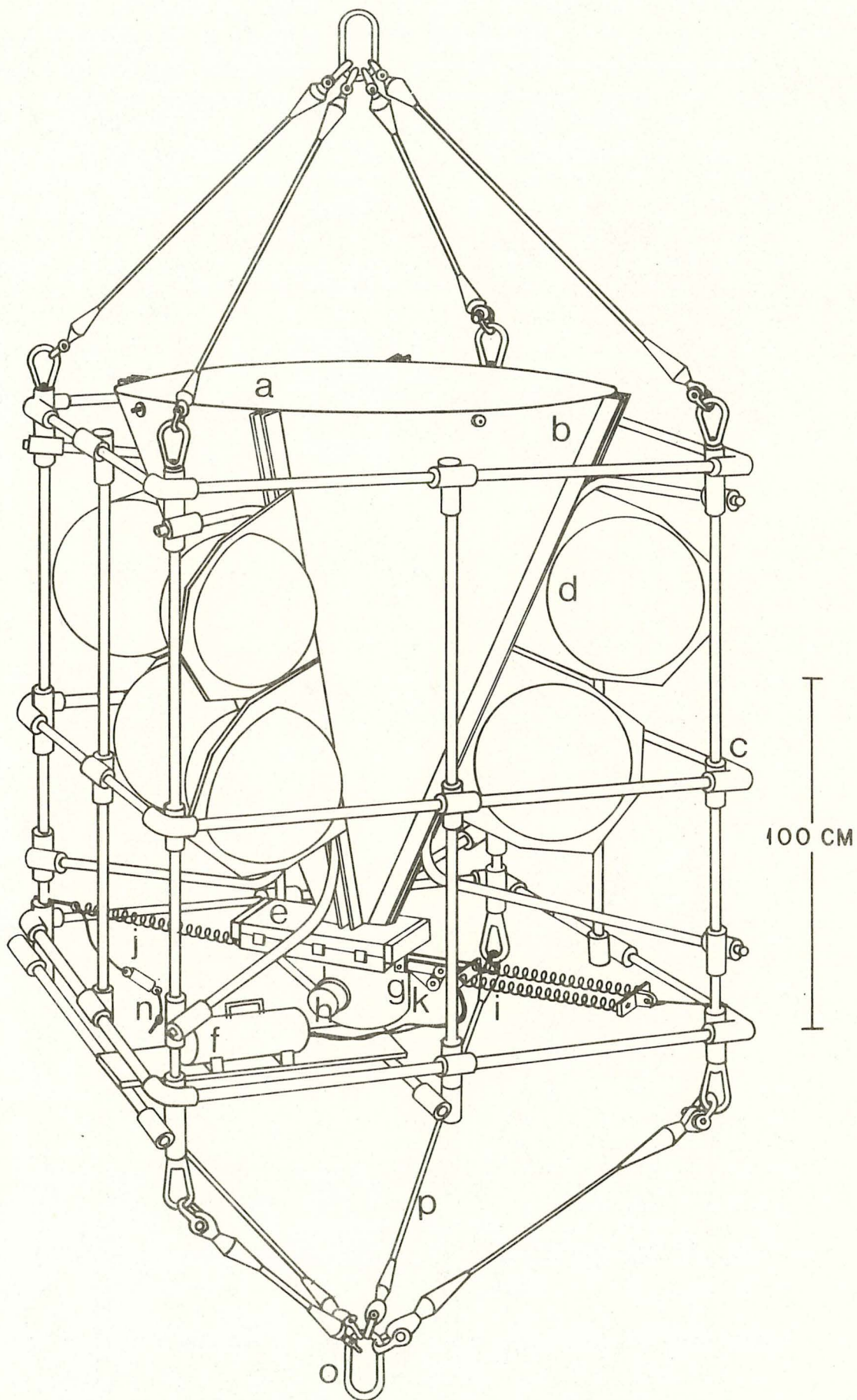
We are intending to use the Type S receiving cup mechanism for further deployments. However, Type C is still useful for certain applications; for example, a short deployment which the timing error caused by the duration corrodible ring dissolution is significant.

Type S Receiving Cup (Fig. 3). The receiving cup mechanism advances three sequences automatically. The funnel is open while a trap descends to the designed depth (open mode). After 24 hours the receiving cup is aligned to the lower opening of the funnel and starts to collect sediment (receiving mode). Before retrieval, the cup closed sealing the accumulated sample and reopening the lower end of the funnel (holding mode).

The favorable characteristics of the PARFLUX S type receiving cup design are: 1) The trap is deployed with the lower end of the funnel being open which results in the immediate flooding of water after launching, leaving less chance of being disturbed by surface waves; 2) The funnel assemblies can be flushed thoroughly by sea water while sinking through the water with a descending speed of approximately 65 m/min. This eliminates the chance of contamination of sample from the surface water; 3) The receiving cup can retain a saline solution with concentrated sodium azide. When the cup slides to the receiving mode, heavier solution stays in the receiving cup and the first arriving particles to the cup are readily sterilized. Thus the sediment maintains an asptic condition throughout the deployment; 4) When the cup is retracted to the holding mode, no water from the sample can leak out from the cup due to the tight seal. The trap can be retrieved on the deck in any position; and 5) the cup assembly can be attached or detached in a matter of seconds.

The mounting plate (a in Fig. 3) is 3/4" thick PVC, 10" wide, 18" (for S type, 12" for C type) long and welded to the bottom opening and the lower ends of the anchoring channel (Fig. 1). The cup assembly (b through g in Fig. 3) is housed in the glider plate (b), and it is attached to the mounting plate by 6 heavy duty buckles (c). Neoprene sheet (1/32" thick) is sandwiched between those two plates. The receiving cup (d) is made of clear 6" diameter, 6" high Lucite^R

Fig. 2. An illustration of a PARFLUX Mark II sediment trap with an S type receiving cup. a: trap opening where a buffer (Fig. 1) is installed; b: a funnel; c: frame; d: flotation spheres (only hard hat covers are shown); e: "moving cup" mechanism; f: a pressure case for timer electronics and batteries; g: a receiving cup; h: bacteriacides diffusion chamber; i and j: spring to move and retain g; k: titanium burnwire. Magnesium corrodible link (n) is now released. Bridles (p) fasten a trap to the mooring line through O-rings (o).



cylinder with 1/4" thick wall. The receiving cup retaining plate (e) was milled from 1/2" Lucite^R sheet stock and glued to the cylinder with a "tongue and groove" configuration. A Teflon^R coated, Quad-X^R sealing ring, Neoprene^R, is installed in the groove on the upper surface of the plate (g). The grease retaining groove on the sealing-ring should be filled with non-water assimilating silicon lubricant such as General Electric^R SC-206.

The cup assembly slides open and shut along the guide rail (h) with a two stage retraction of a pair of springs with different tension strengths (i and j). These springs are attached to the cup retaining plate (e) via mounting hardware (k) and the other ends are anchored to the vertical tubing of the frame in a diagonal fashion. First, the weaker spring (i) is fastened in a retracted position with a retaining wire (l) which holds the cup in a recessed position during the open mode. The length of the wire can be adjusted by a turn-buckle (m). A magnesium corrodible link (n) dissolves in approximately 24 hours (+ 3 hours) in the seawater. Then the cup assembly is pulled by a double spring (j) and stopped by an end-plate (p) at the position where the holes on b and e align with the bottom opening of the funnel to accomplish the receiving mode. When the burn-wire (q) is fused by a signal from the timer electronics, the receiving cup is released from the pull of a double spring (j) via multiplying lever (r) and it is retracted again to the recessed position by the weak spring (i).

The tension strengths of the double spring (j) and weak spring (i) are approximately 45 lb. and 30 lb. respectively. A lever (r) reduces the pull of the double spring (j) on burnwire (q) by 7.5 times. A typical arrangement for the spring tension usually practiced is illustrated in Fig. 4. The burnwire is stretched between two pulleys (s) with less than 7 lb. protecting the junction of titanium wire from metallic fatigue during a long deployment. At this retracted position (hold mode), the cup is sealed against the polished lower surface of the glider plate (b) via Quad-X^R seal (f). Five studball bearings (t) are installed on the guide channel (h) for smooth reciprocation of the receiving cup. The weak spring should retain 15 lb. of retention strength during the holding mode. We used 25 cm long 14 1/2" (ID) tight coiled, type 316 stainless springs.

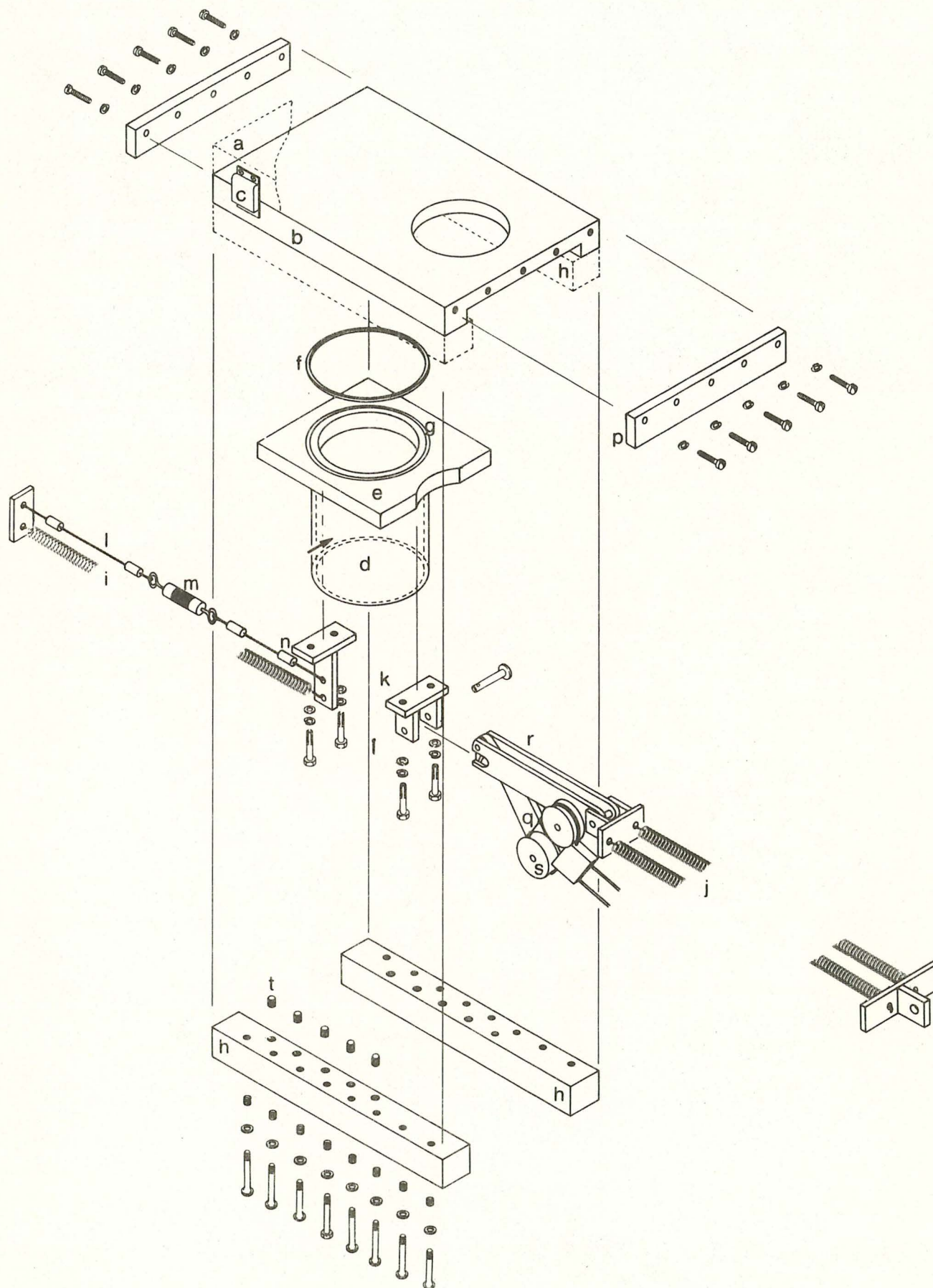


Fig. 3. Assemblage schematics of an s-type gneiss.

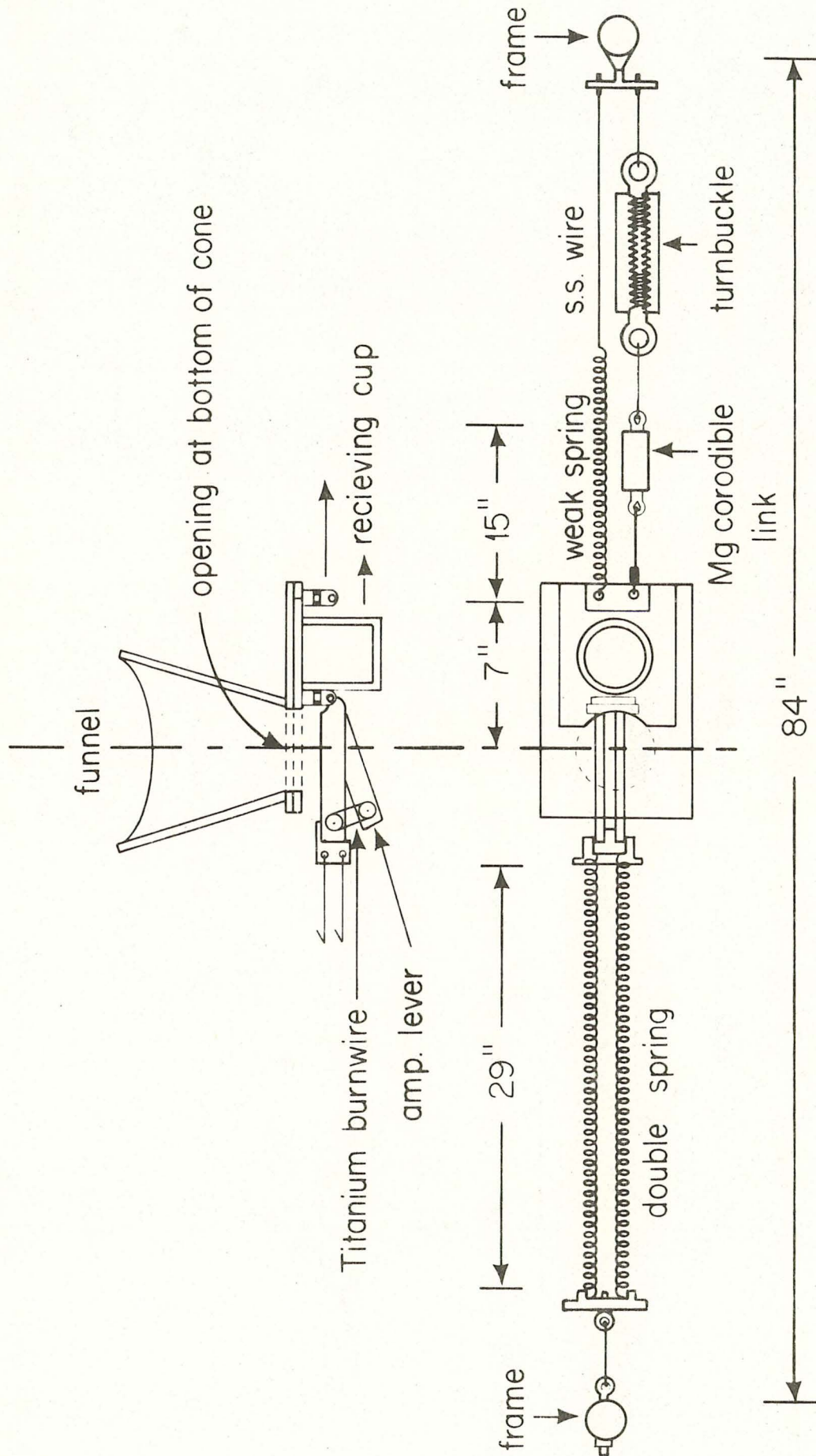


Fig. 4. Appropriate spring load arrangement for PARFLUX Mark II S type. The configuration of the length of three springs are 5/8"x12", 0023" thick stainless steel wire (part no. 03S006). The original of this figure was provided by Mr. Peter Sachs, Woods Hole Oceanographic Institution.

Type C Receiving Cup (Fig. 6). Type C receiving cup mechanism involves one movement of relatively light weight shutter made of Devlin^R. A trap is deployed with the receiving cup open. Water emerges from the gaps between the face plate and shutter and it takes over ten minutes before a trap submerges. When the burnwire is cut by the signal from the timer release, common as Type S, the shutter closes the receiving cup and the contents are tightly sealed by retention springs (Fig. 6i) and sliders (K) which push the shutter (e). An advantage of a Type C mechanism is that this is much simpler than a Type S involving less moving parts and less adjustment is required.

The mounting plate (a) is 3/4" thick PVC, 10"x10", and welded to the bottom opening and lower ends of the anchoring channel (Fig. 5). The cup assembly is attached to the facer plate (b) by eight (8) sets of tension springs (u), washers and machine bolts (w). The dimension of the receiving cup is the same as in Type S (Fig. 3). A Teflon^R coated, Neoprene^R, Quard-x^R sealing ring (f) is installed in the groove on the upper surface of plate (g). The grease retainer groove on the sealing-ring should be filled with non-water assimilating silicon lubricant such as General Electric^R SC-206.

A shutter (e), 1/2"x6"x18" Delrin sheet, is sandwiched between the facer plate (b) and sealing ring (f) via sliders (k) with compressor springs (j). The hole on the shutter should be aligned through the holes on the mounting plate, cup opening and the bottom of the funnell. This can be adjusted by the turnbuckle (m) after installing the burnwire (q) via two blocks (s) and loose joint (n) with a pin (h). While assembling the receiving cup mechanism, sliders (k) with compressor springs (j) tend to drop from the retaining grooves on the facer plate (b)(indicated by broken lines); therefore, it is recommended to fastern them temporarily by a pair of set screws (l).

The length of tension spring should be adjusted from 12" to 10 1/2" depending upon the fixture which holds the spring at the far end. The standard tension of the shutter is 17 lb. during the receiving mode; 6 lb. of retaining tension is necessary to hold the shutter at the closed position. Slider and lower surface of the shutter should be lubricated by applying the thin but consistent film of GER^R SC-206 compound.

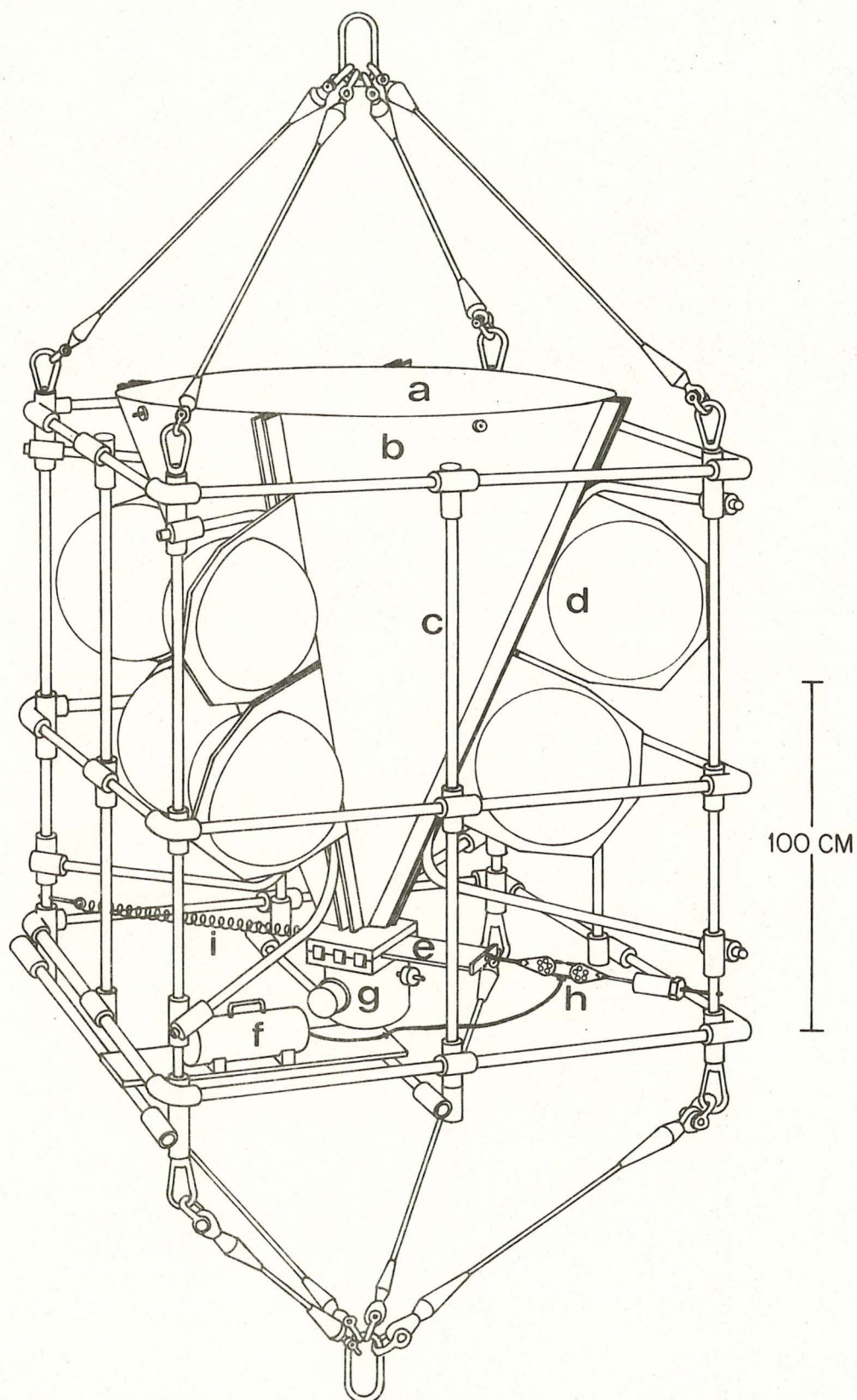


Fig. 5. An illustration of a PARFLUX Mark II sediment trap with a C type receiving cup. a to d is the same as in Fig. 2. E: shutter plate, h: burnwire, i, single spring to shut and retain e.

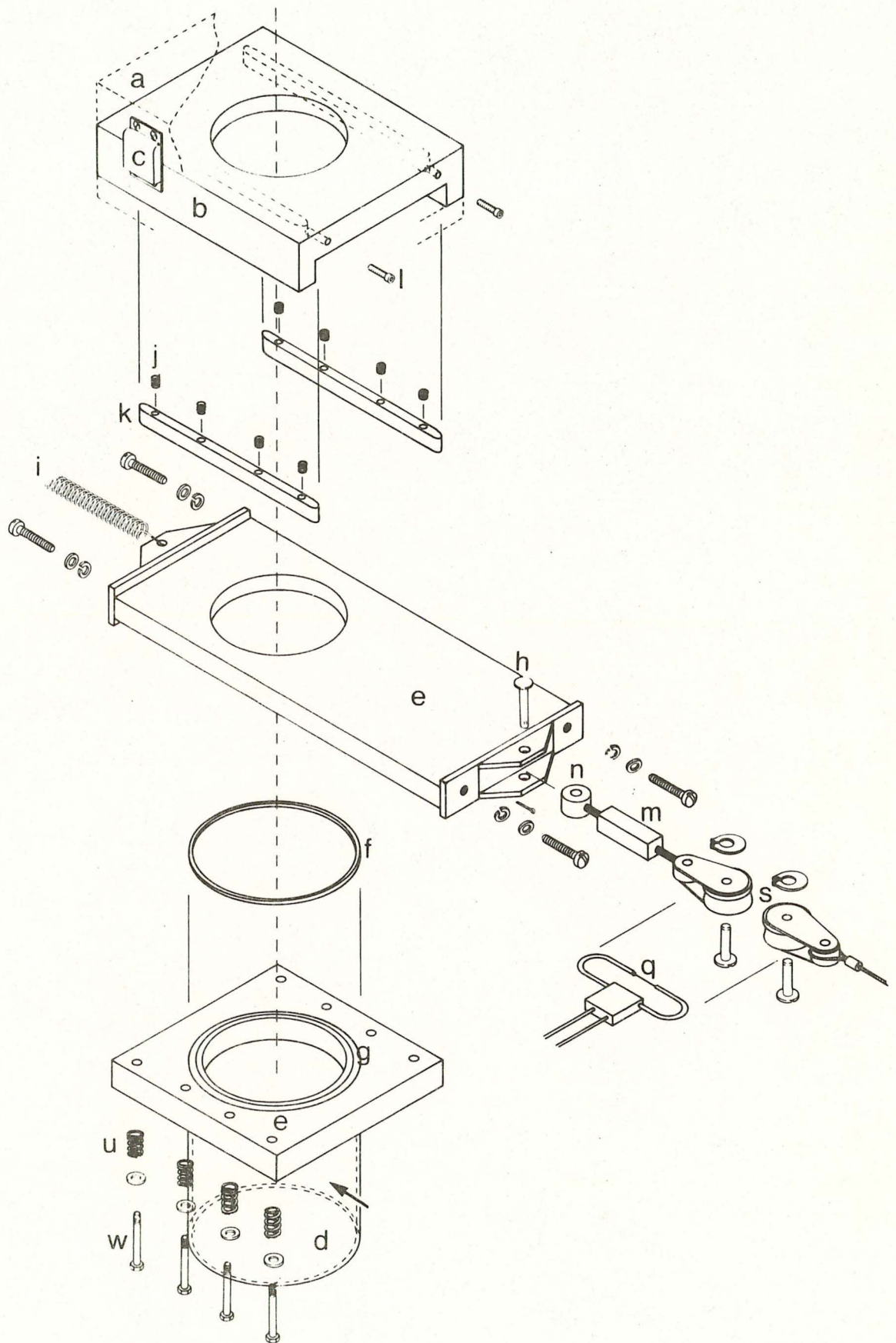


Fig. 6. Assemblage schematics of a C type receiving cup.
Refer to text.

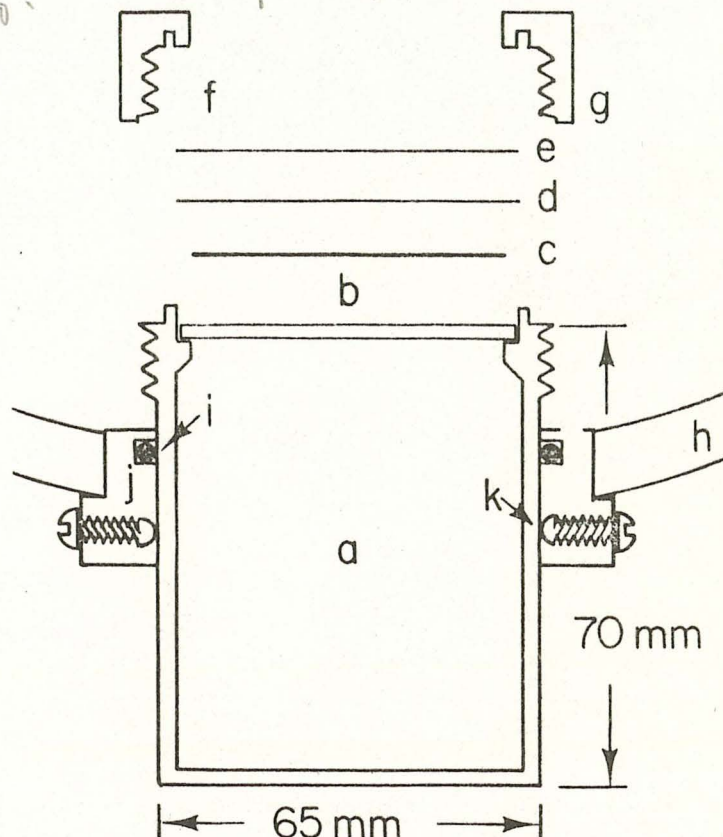
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Fig. 7. Bacteriacides chambers or sodium azide diffusion cup (part number 0350BC). a: chamber to store sodium azide/sodium chloride mixture, b: Lexan^R retainer from Nucleopore^R-47 with non-skid filter cap, c: 42 mm Whatman #2 filter, d: 47 mm Millipore^R 0.46 μ m membrane filter, e: Nucle-pore^R 0.2 μ m membrane filter, f: Neoprene^R 47-1-3 flat gasket, g: Lexan^R top screw from Nucleopore^R-47, h: receiving cup, i: Neoprene^R O-ring 65-2, j: O-ring retainer, Lucite^R, glued to h, k: Nylon^R set screw.



Bacteriacides chamber. Bacteriacide chambers are 6.5 cm in diameter (OD), 7 cm high, and 3 mm wall thickness (Lucite^R cylinder). One end is closed and the other was fitted with a commercially available 45 mm membrane filter retainer (Fig. 7). The lower half of the cylinder is packed by sodium azide (refer to Appendix 1) and sodium chloride at a ratio of 4 to 1 in weight. The rest is filled with a mixture of the same material but in reversed ratio. It requires 60 grams of sodium azide. The open-end of the cylinder is covered with a lamination of filters; from bottom to top 4.25 cm diameter Whatman #1 filter, 47 mm Millipore filter with the nominal perforation of 0.2 μ m. The lamination is mounted to the container by a threaded adaptor with a silicon rubber gasket. The container was then placed through a hole in the side of the receiving cup (for mounting refer to Figs. 2 and 5, also location indicated by an arrow mark in Figs. 3d and 6d) through an O-ring and anchoring Nylon^R bolts. The filter side of the cylinder is exposed to the inside of the chamber.

Special Caution in handling sodium azide is explained in the Appendix of this report.

Electronic Timer (refer Appendix 2 for details)

The electronic timer (Fig. 2f and Fig. 5f) is a quartz oscillator clock device developed by Benthos^R Inc. The electronics and batteries are housed in a 4 1/2" diameter (OD), 10" long stainless steel pressure housing. The time duration can be adjusted from one hour to 9,999 hours in one hour increments. The circuit can be tested by a fast run mode converting hours to seconds. The timing error at room temperature is less than 60 minutes for 12 months of deployment. We also have successfully used WHOI-Williams electronic timers.

The burnwire is a 10" long, number 16 titanium wire that is formed into a loop by electron beam welding at the ends. The loop is hot-coated by 1 mm thick Neoprene insulation leaving a 1.5 mm slit where the titanium wire is exposed. A submersible electric cable from the battery via relay is connected to the loop. Timer signal is relayed to two independent sets of burnwire current supplies in order to be fail-safe. Recommended voltage is 64 volts DC or more. Tension strength (momentary) of an insulated loop is 125 lb. in a laboratory test. It takes approximately 30 seconds to corrode a burnwire at 2°C under 10 lb. of tension at ambient pressure supplying 64 V DC. The burnwire for an OSI-Williams timer is made of number 18 stainless steel wire. Specification is available in Williams' internal memorandum, issue to "list" in July 1976.

Frame

The dimension of a frame is 183 cm high (excluding eyebolts), 162x162 cm deep square at the base and is made of 1 1/2" schedule 40, marine grade, class 6001 aluminum tubing. All the corners and cross-bars were furnished with marine grade aluminum fittings (Figs. 2 and 5). A trap requires a total of 48.8 m of tubings and 37 matching fittings (25 "T"s and 12 corners). A threaded rod of 1" diameter is inserted through four vertical tubings via Telfon^R snug-fit bushings. 2" eyebolts and 2" shackles were attached to both ends of a rod to accept the bridles made of 3/8" vinyl coated steel wire. The tensile strength between both ends of bridles are tested to 5 tons.

Four 2" aluminium tubes are bent 24 and 62 degrees to form a deviated U-shape and mounted diagonally to the four vertical tubes (Figs. 2 and 5). A 1/8" thick Neoprene^R sheet is padded throughout the inside of the anchoring channels along the frustrum. The funnel is fastened with 3/8" stainless steel bolts through 1" diameter Neoprene^R shock absorbing bushings.

It has been found that the deployment/recovery is eased significantly by providing each sediment trap with slightly positive buoyancy (30 lb.) which is enough to resist sinking by the weight of the adjacent wire shots. This much buoyancy does not sacrifice the stability of the trap while being deployed. We have installed eight 17" diameter, Benthos^R, Pyrex^R buoyancy spheres covered by ABS resin hard hats. Two spheres are mounted on a U-shaped tube by 3/8" stainless steel bolts via Teflon^R insulation tubes.

Prevention of Corrosion

All the contacts between stainless steel and aluminum are insulated with nylon bushings and washers. All the threaded surfaces are coated with Teflon^R sealing paste. Four 1/2 lb. zinc anodes are mounted on the lower part of the frame. A smaller anode (1/16 lb.) is also mounted on the pressure case which houses electronic timers.

During the last 50 months, PARFLUX traps have been deployed up to 12 months in water. On many occasions, some traps were stored in near-shore open storage for several months. In one case they were on-board outside for a few months while a ship cruised in the tropical areas. Despite those adverse conditions, the PARFLUX sediment traps have not undergone significant wear and corrosion. The surface quality of PVC was checked frequently under the SEM using test pieces deployed with the traps; no significant change in surface smoothness was found. Plate 4 illustrates comparison of the PVC (Troidour^R) 6001 aluminum and 360 stainless steel before and after the three subsequent deployments totalling 283 days at the bathypelagic depth.

A trap should be thoroughly rinsed by fresh water immediately after recovery and before land storage. Also, the trap should be washed thoroughly with a mild detergent mixed in 50°C water before deployment.

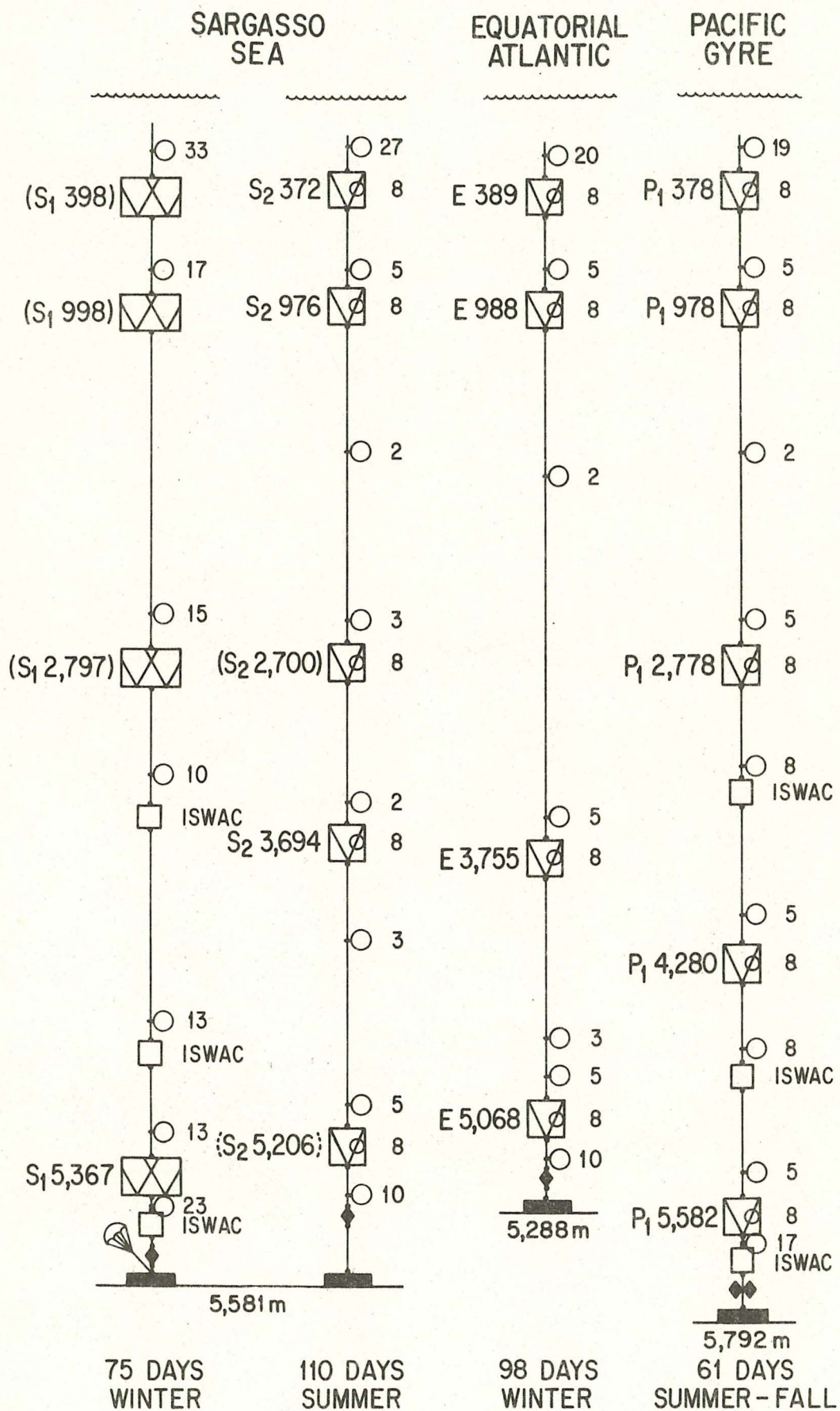
Mooring Array

We used 3/16" steel tautline with polyethylene coating. The tensile strength of the line is tested to 2.5 tons. Thirty meters of 3/4" nylon shots are deployed above and below a trap.

As shown in Fig. 8, the sediment traps were deployed in various depths from 400 m to 5,685 m. In order to minimize the swiveling motion of the mooring and to keep the opening as horizontal as possible, the mooring line tension above the traps was kept at 1,300 lb. to 1,500 lb. A model calculation of the Equatorial Atlantic array in Fig. 8 indicates that the

possible tilt from vertical at 5,068 m, 3,755 m, 988 m and 377 m is 12° , 10° , 7° and 4° respectively under hypothetical uniform advection of 30 cm/sec. Considering surface current shear and animal attacks, it appears that approximately 400 m is the shallowest a sediment trap can be deployed with satisfactory performance. On the other hand, pressure resistance of instrument pressure cases is the only limiting factor for the deepest deployment.

Since the reliability of our acoustic releases has been very high if proper preparation is maintained (99.9% of recovery rate by the Moored Array Management, Woods Hole Oceanographic Institution), we used a single release throughout the experiment except for the P_1 array which had a tandem release. The details of the PARFLUX mooring design and its performance will be reported elsewhere (Clay and Honjo, in prep.).



Result and Discussion

The benefit of a large opening of the PARFLUX Mark II trap well cancels out some of the inevitable disadvantages of being large and heavy. For example, the bathypelagic Sargasso Sea is presumed to be one of the most barren waters in terms of the flux of sediment because of its low productivity and distance from land; we have collected approximately 1.5 to 2 grams of sample during 110 days of deployment, which proved sufficient to carry on multi-disciplinary research including radiochemistry (Honjo, 1978; Spencer et al., 1978). Table 1 shows the volume of sediment collected in the traps and calculated flux so far deployed in the open sea (Honjo, in press). The recent Panama Basin experiment (PARFLUX P₂) collected up to 50 grams of pelagic sediment during 112 days of deployment.

Gardner (1978) measured the trap's efficiency (% of vertical flux) by different shapes in slow advection of flume water equivalent to several centimeters per second in the laboratory. Such current velocity was typical in the mesopelagic and bathypelagic water of the large open sea (i.e. Schmitz, 1978, 1979). Gardner (1978) observed that 1) the collecting efficiency of a trap of fine grained oceanic sediment particles (95% were smaller than 25 μ m) is a function of the residence time and flow pattern of fluid within the trap at a given velocity, 2) the flow pattern is decided by the geometry of the sediment trap, and 3) the particles of the size range above mentioned are collected through a process of fluid exchange rather than falling freely into a trap. The same paper reported that a shallow funnel whose opening is parallel to the flow direction generates an upwelling along the far-side slope of a funnel which tends to cause undertrapping of particles. His scaled-down model of the sediment trap using a funnel and buffer, somewhat similar to a PARFLUX Mark II, showed 65 to 90% of trap efficiencies at 5 cm/sec advection. The funnel angle of our trap was much steeper than the funnel he used in his experiment; 45° vs. 12°, resulting in the fluid residence time in our trap being significantly longer than in Gardner's experiment. However, there has been evidence that such laboratory results would be applicable to the field.

Since the ^{230}Th concentration in sea water is negligible compared to that of ^{234}U , one can assume that the production rate of ^{230}Th by the decay of ^{234}U in the water column above the trap is equal to the vertical flux of ^{230}Th at the depth of the trap deployed (Spencer et al., 1978). Thus by comparing the measured ^{230}Th flux with the calculated production rate of ^{230}Th , a trapping efficiency may be calculated. Brewer et al. (in press) estimated trapping efficiencies for particles on ^{230}Th 70, 78, 78 and 67% for

398 m, 988 m, 3755 m and 5086 m traps deployed at the PARFLUX E site, in the Equatorial Atlantic. Deep current velocity in this area is believed to be equivalent to the other two experimental sites (Honjo, 1980, in press).

Realistic concentration of sodium azide in the receiving cup while the trap is being deployed is not known. A tank experiment with still seawater under ambient temperatures demonstrated that the salinity of the water inside of the cup increases continuously up to 15 days and maintains the higher salinity for at least 9 weeks up to the opening of the receiving cup (unpublished). It is assumed that sodium azide remained with heavier saline water in the cup and this aseptic environment is provided for possibly as long as several months under bathypelagic conditions. In about 20% of the traps deployed so far there remained a few grams of sodium azide in the bacterioides chamber. Assuming that sodium azide diffused in like manner, a rough estimate of the rate of diffusion is 300 mg/day average. The volume of the receiving cup (including the thickness of the face plate) is approximately 3 liters and the estimated exchange rate is approximately 100 ppm/day. The bacteria over the fecal pellets (Honjo and Roman, 1978; Turner, 1979) were not recognized under SEM in any samples even from 400 m traps. No trace of bacterial growth was recognized in a poisoned cup (Sargasso Sea sample from 5,356 m) after being stored in 2°C and 10°C for 10 months after recovery. Systematic change of organic carbon and nitrogen contents were not recognized after several months the samples were kept in cold storage in the original poisoned water recovered with a receiving cup for at least 10 months.

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PARTS LIST

Parts necessary to construct a PARFLUX Mark II are listed in the following section. Type S and C receiving mechanisms differ significantly. Therefore, the respective parts lists were separately prepared.

- 02: Collector subsystem
- 03C and 03S: Receiving cup subsystem
- 04: Timer electronics subsystem
- 01: Framework subsystem
- 10: Mooring array (not included)

Assemblage position of those parts can be referred to the illustrations in Figs. 1 through 7. The list should be read in the following order:

1. PARFLUX parts number
2. Name of the parts
3. Material to be used
4. Description, specification for order
5. Number of part required to construct a trap
6. Number of optimal spare part to be brought to a deployment cruise.
7. Price per piece if supplied from inventory. Unless specified, published price is as of November 1, 1979.
8. Distributor, supplier or manufacturer. Valid only for the northeastern coastal United States.
9. Order item (o), stock item (s), blue print item (b, item needs to be manufactured in accordance with PARFLUX specifications).

01 FRAMEWORK SUBSYSTEM

1. 01001
2. Frame (Figs. 2 and 5c)
- 3,4. 1 1/2" diameter, class 6001-T6 aluminum pipe, schedule 40
5. 50 m per set (exact length needed; 48.8 m)
6. \$1.37/ft.
7. 0
8. Peter Frasse & Co., Inc.
87 Ridge Ave. Ext.
Cambridge, MA 02140
9. s

1. 01002
2. Pipe fittings (Figs. 2 and 5)
- 3-7. 1 1/2", schedule 40 rated marine grade (6001) molded aluminum Hollander Structural fittings for 1 1/2" pipe. Hollander # 10 TSD CORNER, 12 ea., \$7.90 ea. Hollander #20 CROSS, 16 ea., \$5.28 ea.
8. Babbit Steam & Specialty Co.
800 Mt. Pleasant Street
New Bedford, MA 02745
9. s

1. 01003
2. Floatation spheres (Figs. 2d and 5d)
3. Pyrex^R glass sphere with ABS resin hard-hats
4. 43 cm diameter glass sphere encased in plastic hard hat used for floatation. Spheres must be tested (by factory or in the field) at 17,000 psi. Regular lib-hats are recommended.
5. 8
6. Spheres, BENTHOS 2040-17V, \$276 ea: hats, BENTHOS 204HR-17, \$48 ea.
7. 0 (1/4 number of trap inventory)
8. Benthos Inc.
Edgerton Drive
North Falmouth, MA 02556
9. s

1. 01004
2. Pressure-case retaining stand (Figs. 2 and 5, supports f)
3. 1/2" aluminum sheet stock
4. Blue prints available for the following items: 1. For BENTHOS 885-2 time release, 1/2" aluminum sheet is cut to 12"x27" and welded in crossing the two tubings at the bottom. A pair of aluminum stands with 1/8" thick aluminum straps hold the electronics pressure case. Stainless steel case and aluminum stand/strap are

insulated with 1/16" Neoprene^R sheet. 2. for OIS-Williams time release (aluminum casing) a pair of aluminum stands are welded to the inside of a vertical member of tubing. Pressure case is strapped by aluminum 1/8" thick bands.

- 5. 1 set aluminum straps
- 6. 0 (1/4 number of trap inventory)
- 9. b

- 1. 01005
- 2. Hose clamps (Figs. 2d and 5d)
- 3. 314 or 360 stainless steel
- 4. Assortment of large sized hose-clamps ranging from M60 to M104 is required to hold floatation spheres connecting hardhats to the framework. This avoids swaying of spheres and gives stability during transportation.
- 5. 16 to 20
- 6. 4
- 8. AeroSeal^R, QS200, M60 to M104. Manufactured by Breeze, Inc., Union, N.J. Local hardware shop.
- 9. s

- 1. 01006
- 2. Zinc anode (Figs. 2c and 5c)
- 3. Zinc nigot
- 4. 1/8 lb. and 1/16 zinc ingret is fastened to stainless steel L shaped steel holder. Attached to the lower part of the aluminum (1/8 lb.) tubings and a pressure case (1/16 lb.) for up to 4 months deployment.
- 5. 4 1/8 lb., 1 1/16 lb.
- 6. 2 1/8 lb.
- 9. b

02 COLLECTOR Subsystem

- 1. 02001
- 2. Sediment trap funnell (Figs. 2b and 5b)
- 3. PVC, Trovidour^R, 3/8" sheet stock
- 4. (Order specification) Opening (ID): 140 cm top and 10 cm bottom. Frustrum height 170 cm. Material is 3/8" thick Trovidour and heat processed as per agreed, single structure. Top and bottom finished flat. Seam lines on a frustrum must be less than 3 and joined by 4 corner/45 degree/double welding method. Polished inside as per instructed. Accessories to be included in this order: 4 ribs of two plates for an choring are 1/2" Trovidour^R and welded to the frustrum as per requested.

5. 1
6. 0 (20% of trap inventory)
8. Ayer Sales, Inc.
2 Industrial Parkway
Woburn, MA 01801
9. b

1. 02002
2. Honeycomb buffer cells (Fig. 1)
3. PVC, Trovidour^R, 1/16" sheet stock.
4. (Order specification) WHOI developed continuous bend construction (memorandum by S. Honjo, April 29, 1976); 96 hexagonal cells, 7 cm edge length. Tapered to fit top opening of funnell as requested.
5. 1 ea.
6. Optional 1 (25% of the number of trap inventory)
7. Ayer Sales, Inc.
2 Industrial Parkway
Woburn, MA 01801
8. b

1. 02004
2. Honeycomb buffer retaining rods (Fig. 2)
3. 14" 360 stainless steel threaded rod coated with Teflon TEE, with matching bolts. Plans available.
4. Inserted through hole between frustrum and honeycomb anchoring buffer to funnell.
5. 3 ea.
6. 1 ea.
9. Teflon^R TEE coated threaded rod is an order item.
Usually small modification required to fit a honeycomb.

03S RECEIVING CUP Subsystem Type S

1. 03S001
2. Cup holder matching face plate
3. 2" PVC sheet stock
4. Welded to bottom of collection cone. 12"x18". Plan available.
5. 1 ea.
6. 0
9. b

1. 03S002
2. Glider plate types (Fig. 3b)
3. 2" PVC sheet stock
4. Made of 2" PVC and fastens to matching face plate.
12"x18". Milled at 1 mil precision. Plan available.
5. 1
6. 0 (1/4 number of trap inventory)
9. b

1. 03S003 (03C003)
2. Compression spring catches and stike plate on glider
plate (Fig. 3c)
3. 360 stainless steel fastener
4. For attaching cup holder. Matching face plate part #6 to
cup holder, face plate part #a. Compression spring catch
(SC-3-3314-2, SS302), strikeplate #HS 179286-255.
5. 6 pairs
6. 2 pairs
7. 80 cents ea.
8. Neilson Hardware Corp.
P.O. Box 568
770 Withersfield Ave.
Hartford, CT 06101
9. s

1. 03S004
2. Receiving cup (Fig. 3d)
3. Plexiglass^R tube. 6" OD, 3/16 W.T. plexiglass 3/4"
sheet stock.
4. Cup 6"x6" attached to a 5/8x10" face plate with a water
tight seal. Precision 1 mil. Plan available.
5. 1
6. 0
9. b

1. 03S005 (03C005)
2. Sediment cup sliding seal (Fig. 3f, inst. in Fig. 3g)
3. Neoprene^R
4. Teflon^R coated, Quad X Brand Seal, part #Q4252
5. 1 ea.
6. 1 ea.
7. \$1.92 ea.
8. I.B. Moore Corp.
30 Ringe Avenue Ext.
Cambridge, MA
9. s

1. 03S006 (03C006)
2. Tension springs (Fig. 3h)
3. 360 stainless steel
4. 5/8x12" long, .023 wires, stainless steel used to move gate in. Length can be adjusted 12" to 10".
5. 3
6. 2
7. \$2.50 ea.
8. Hardware Products
24 Fulton Street
Boston, MA 02113
9. s

1. 03S007
2. Bearing surface face plate
3. PVC 1" sheet stock
4. PVC 1"x1"x12" holder for ball bearing and retainer for collection cup. Milled at 1 mil precision. Plans available.
5. 2
6. 0
9. b

1. 03S007-1
2. Bearing surface face plate retaining bolts (Fig. 3h)
3. Stainless steel
4. 1/4 20 x 3" matching Taprock^R insertions on 03S002
5. 16
6. 25
7. 2
8. General Supply and Metals
47 Nauset Street
New Bedford, MA 02746
9. s

1. 03S007-2
2. Compression spring (Fig. 3h)
3. 360 stainless steel
4. 3/8x.058x9/6x8 pitch compression spring. Retain tension between the face plate of 03S004 and 03S002 via 03S005.
5. 8
6. 2
7. 50 cents
8. Hardware Products Co.
24 Fulton Street
Boston, MA 02113
9. s

1. 03S008
2. Holding fixture (Fig. 3k)
3. 1/8" stainless steel sheet stock
4. Fixture used for holding springs and release mechanisms. Plan available.
5. 5
6. 0
9. b

1. 03S008-1
2. Holding fixture retaining bolts (Fig. 3r)
3. 360 stainless steel
4. 1/4x20x1". Retains 03S008 to 03S004, machine bolts with top 3/4" threaded with matching washer and rock washers. Matching Taprock^R mentions in 03S004.
5. 4 ea.
6. 2 ea.
7. 55 cents a set
8. General Supply and Metals, Inc.
47 Nauset Street
New Bedford, MA 02746
9. s

1. 03S009
2. Amplifying lever
3. 1/4" 360 stainless steel sheet stock
4. Release hook, 12" long x 1 1/2", used to reduce tension on titanium release link at the ratio of 15:1. Refer to memorandum by A. Williams, WHOI, July 1976. Plan available.
5. 1
6. 0
9. b

1. 03S010
2. End plates (Fig. 3p)
3. PVC 02" sheet stock
4. Plates used as stopping index for collection cup. Plan available.
5. 2
6. 2 (this plate tends to be damaged during test)
9. b

1. 03S010-1
2. End plate retaining bolts (Fig. 3p)
3. 360 stainless steel
4. 1/4 20x1" bolts with matching washer (not shown in Fig. 3) and rock washers. Ten (10) 1/4 20 Taprock^R insertions on 03S002.

5. 10 ea.
6. 2 ea.
7. 58 a set
8. General Supplies and Metals, Inc.
47 Nauset Street
New Bedford, MA 02746
9. s

1. 03S011
2. Stud ball bearing (Fig. 3k)
3. 360 stainless steel
4. 1/4" d is ball bearing to reduce friction between face plate cup and matching face plate. 1/4" 20 matching Taprock^R insertion on 03S007.
5. 8
6. 2
7. \$1.23 ea.
8. Atlantic Tracy Co.
100 Messina Drive
Braintree, MA 02184
9. s

1. 03S012
2. 24 hour corrodible link (Fig. 3n)
3. Magnesium 1/4" bar stock, or ready made
4. Magnesium release link design to dissolve in approx. 24 hours. Avoid contamination.
5. 1 ea.
6. 2 ea. (ready-made items need thorough inspection)
7. 20 cents ea.
8. Wilcox Marine Supply
P.O. Drawer 99
Mystic, CT 06355
9. s

1. 03S013
2. Tension wire (Fig. 31)
3. 1/6", 6 strand stainless steel wire
4. End terminal stainless steel 1/6" Nicopress^R
5. Set (a piece of wire and 2 terminals ea.)
8. For wire and micropress fittings:
C.G. Edwards & Co., Inc.
272 Dorchester Avenue
South Boston, MA 02127

1. 03S0BC (common to 03C0BC)
2. Bacteriacides chamber or sodium azide diffusion cup (Fig. 7)

3. Lucite^R or Plexiglass^R, 2 3/4" bar stock
4. 6.5 cm in diameter (OD), 7 cm high and 3 mm wall thickness cup. One end is closed and the other is fitted with a 47 mm membrane filter retainer (Nucleopore^R). Plan available.
5. 1
6. Require spare filters. NaN₃ (reagent grade) and NaCl is consumptive.
9. b

-- IMPORTANT: READ APPENDIX OF THIS REPORT FOR SAFETY PRECAUTIONS FOR HANDLING SODIUM AZIDE (NaN₃) --

03C RECEIVING CUP Subsystem Type C

1. 03C001
2. Mounting plate, Type C plate (Fig. 6a)
3. PVC 2" sheet stock
4. Made of 2" PVC and welded to bottom of collection cone. No milling required. Plan available.
5. 1 ea.
6. 0
9. b

1. 03C002
2. Glider plate, Type C (Fig. 6b)
3. Matching PVC sheet stock
4. Fastens to matching face plate and houses two sliders. Milled at 1 mil precision plan available.
5. 1
6. 0 (20% number of traps inventory)
9. b

1. 03C003
2. Compression spring catch and strike plate on glider plate (03C002) (Fig. 6c)
3. 360 stainless steel
4. Fastener for attaching cup holder matching face plate part b to cup holder face plate part a. Compression spring catch SC-3-3314-2, SS302, Strike plate #HS179286-255.
5. Neilson Hardware Corp.
P.O. Box 568
770 Withersfield Avenue
Hartford, CT 06101
9. s

1. 03C004
2. Receiving cup (Fig. 6d)
3. Plexiglass^R 6" (OD) tube with 3/16" W.T. and 3/4" sheet stock (for face plate).
4. Cup 6"x6" attached to a 5/8x10" face plate with a water tight seal. Milled and bathed at 1 mil precision. Plan available.
5. 1
6. 0 (50% number of trap inventory)
9. b

1. 03C004
2. Shutter (Fig. 6e)
3. Delrin^R 5/8" sheet stock
4. 1/2"x6"x18" Delrin^R door milled at 1 mil precision. Plan available.
5. 1
6. 0 (20% number of trap inventory)
9. b

1. 03C005 (03S005)
2. Sediment cup sliding seal (Fig. 6f)
3. Neoprene^R
4. Teflon^R coated Quad^R Brand Seal, part #Q4252
5. 1 ea.
6. 1 ea.
7. \$1.92 ea.
8. I.B. Moore Corp.
30 Ringe Avenue Ext.
Cambridge, MA
9. s

1. 03C006 (03S006)
2. Tension spring
3. 360 stainless steel 518x12" long
4. 5/8x10 to 12" (length adjusted to frame; minimum, 10"), wire diam. used to move shutter (03C004)
5. 1
6. 1
7. \$2.50 ea.
8. Hardware Products Co.
24 Fulton Street
Boston, MA 02113
9. s

1. 03C007
2. Slider spring (Fig. 6j)
3. 360 stainless steel

4. 1/4"x1/2" compression spring 0.004" wire diameter used for back pressure on slider.
5. 12
6. 4
7. 50 cents ea.
8. Hardware Products Co.
24 Fulton Street
Boston, MA 02113
9. s

1. 03C008
2. Slider (Fig. 6k)
3. Delrin 5/8" sheet stock
4. Slider provides low friction surface for the movement of gate valve door, made of Delrin^R sheet stock, remilled at 1 mil precision. Plan available.
5. 2
6. 1
9. b

1. 03C009
2. Turnbuckle (Fig. 6m)
3. 360 stainless steel 2 1/2 square bar stock
4. 2 1/2" stainless steel used to take slack out of tension lines and align shutter to holes. Plan available.
5. 1
6. 0 (50' number of trap inventory)
9. If the material is guaranteed of being made with 360 stainless steel, any small stock item turnbuckle can be used. Can be manufactured in accordance with PARFLUX specifications (b).

1. 03C010
2. End plate (Fig. 6h in Fig. 6e)
3. 360 stainless steel 1/8" sheet stock
4. Fixture used to hold hardware to end of gate valve. 10 mil precision. Plan available.
5. 2
6. 0
9. b

1. 03C011
2. Holding pulleys for burnwire link (with burnwire, Fig. 6g)
3. 314 stainless steel tackle block
4. Marine grade, 1/4" diameter
5. 2 ea.
6. 1 ea.
7. \$4.20 ea.

8. C.E. Beckman Co.
35 Commercial Street
New Bedford, Ma
9. b (sometimes it is called "Schaifer block")

1. 03C012
2. Compression spring (recessed in Fig. 6e)
3. 360 stainless steel
4. Friction and compression adjustment for shutter movement.
3/8 OD x .047 wire size Q 9/16 long.
5. 8 ea.
6. 2
7. 50 cents ea.
8. Hardware Products Co.
24 Fulton Street
Boston, MA 02113
9. s

1. 03C013
2. Tension adjustment bolts (Fig. 6w in Fig. 6b)
3. 360 stainless steel
4. 1/2 20 x 3" long, machine bolt threaded top 2".
Matching 360 s.s. washer. Matching 360 s.s. Taprock^R
insertions in 03001 (Fig. 6b)
5. 8 ea.
6. 2 ea.
7. 40 cents ea.
8. General Supply and Metals
47 Nauset Street
New Bedford, MA 02746
9. s

1. 03C014
2. Shutter retainer (Fig. 6h)
3. 360 stainless steel. 1/8" thick sheet stock.
Plan available.
4. Requires a pair. Retains tension at burnwire side and
tension spring side of shutter. Also limits the travel
of shutter.
5. 2 ea.
6. 0
9. b

1. 03C015
2. Bolts for shutter retainer (in 03C004; Fig. 6e through
03C014, Fig. 6h)
3. 360 stainless steel

4. Fix shutter retainers at both sides of the shutter.
1/4-20x1", with matching s.s. washer and rock washer.
6. 8 ea. (only 4 are shown in Fig.).
7. 66 cents ea.
8. General Supplies and Metals, Inc.
47 Nauset Street
New Bedford, MA 02746
9. s

04 TIMER ELECTRONICS Subsystem

1. 04001
2. Timed Releases
4. Crystal controlled electronic timed burnwire release,
BENTHOS 855-2, precision 0.025% at 2°C, 9 seconds to
416 days. Stainless steel pressure house to be tested to
17,000 psi for one hour. Fixed with the stand to
framework with 1/2" aluminum plate with helium welding.
Plan for stand available.
5. 1 ea.
6. BENTHOS 855-C circuit board, a spare set of alkaline
batteries as requested.
7. \$2,680
8. Benthos, Inc.
Edgerton Drive
North Falmouth, MA 02556
9. s

1. 04001
4. Also OSI-Williams Timed Release
7. \$544, Pinger release \$9158
8. Oceanographic Instrument Systems, 14 Overy Drive,
Box 766, North Falmouth, MA 02556.
9. s

1. 04002
2. Burnwire (or releasing link) BENTHOS 855-ST or 855-2TR
3. #16, single stand titanium wire with Neoprene insulation.
4. 10" long #16 Ti-wire is formed into a loop by electron
beam welding the ends. The loop is hot-coated with 1 mm
thick Neoprene^R insulation leaving a 1.5 mm slit
leaving titanium wire exposed for dissolution. Momentary
tensile strength loop should be tested at 125 lb.
5. 1 ea.
6. 1 ea.
7. \$92.00; 855-2T; \$52.00 refurbishment, 855-2TR
8. Benthos, Inc.
Edgerton Drive
North Falmouth, MA 02556
9. s

Explanation of Plates

Plate 1. Photograph of a PARFLUX Mark II type S sediment trap. Upper photograph: side view when laid horizontally. Honeycomb buffer (not seen) is on the left side. Lower photograph: bottom view looking upward as being deployed. The receiving cup in "open mode".

Plate 2. Close up photographs of receiving cup moving mechanism. Alphabetical identification of parts correspond to Figure 2. Upper photograph: magnesium corrodible link (n) and a turnbuckle (m) are seen. Lower photograph: double spring side, an amplifying lever (r) with insulated titanium wire (q) is shown.

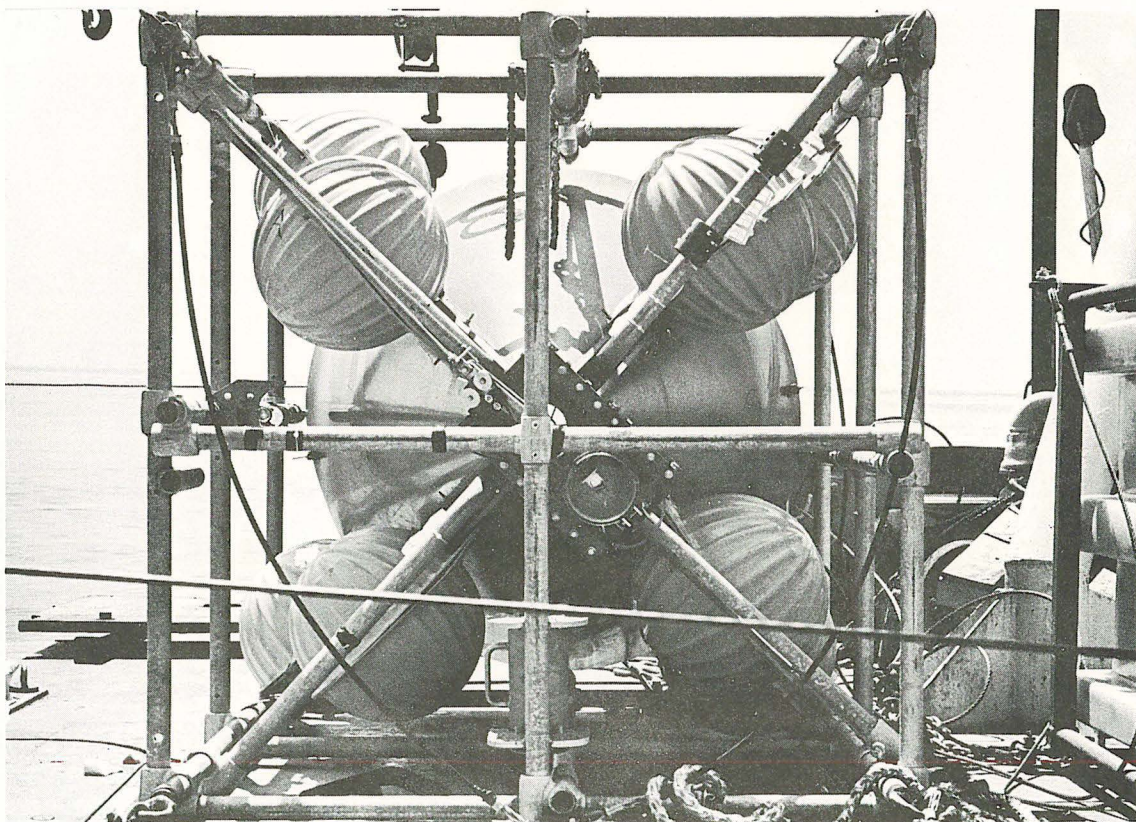
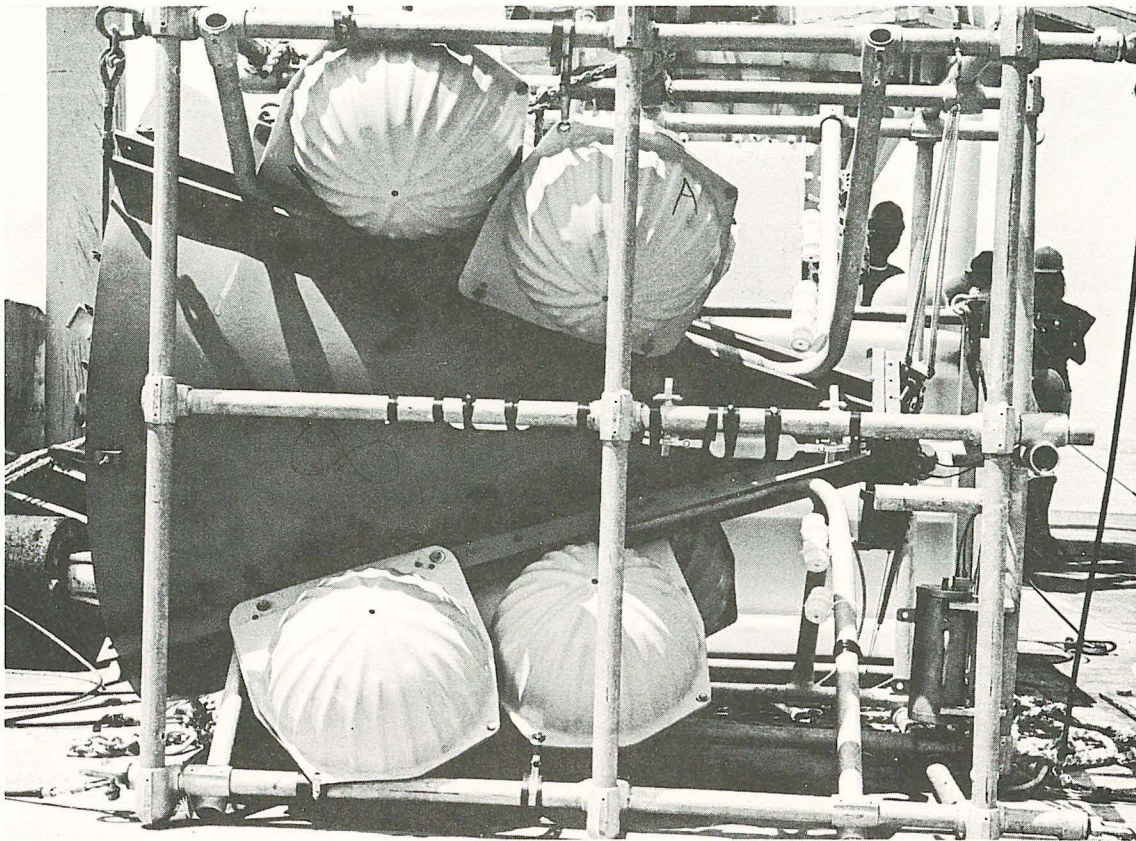
Plate 3. Deployment sequence (A-D) and partial view of type C traps.

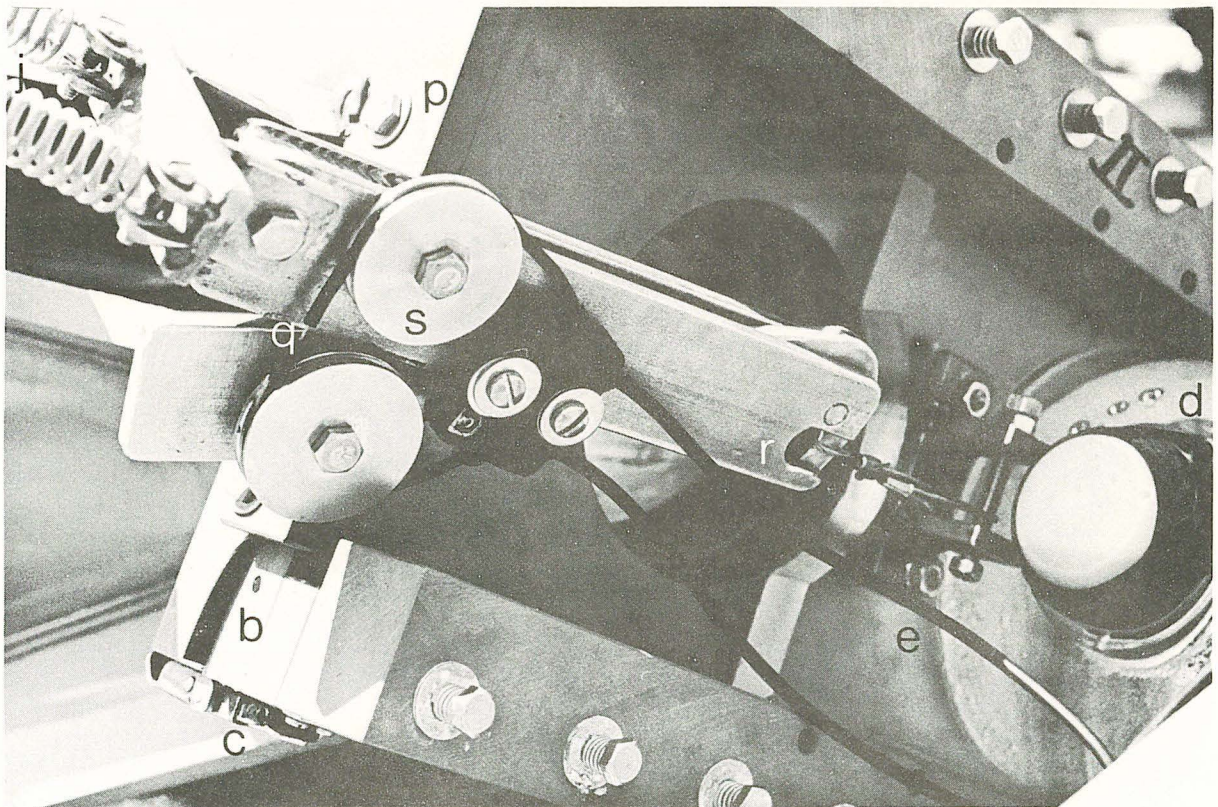
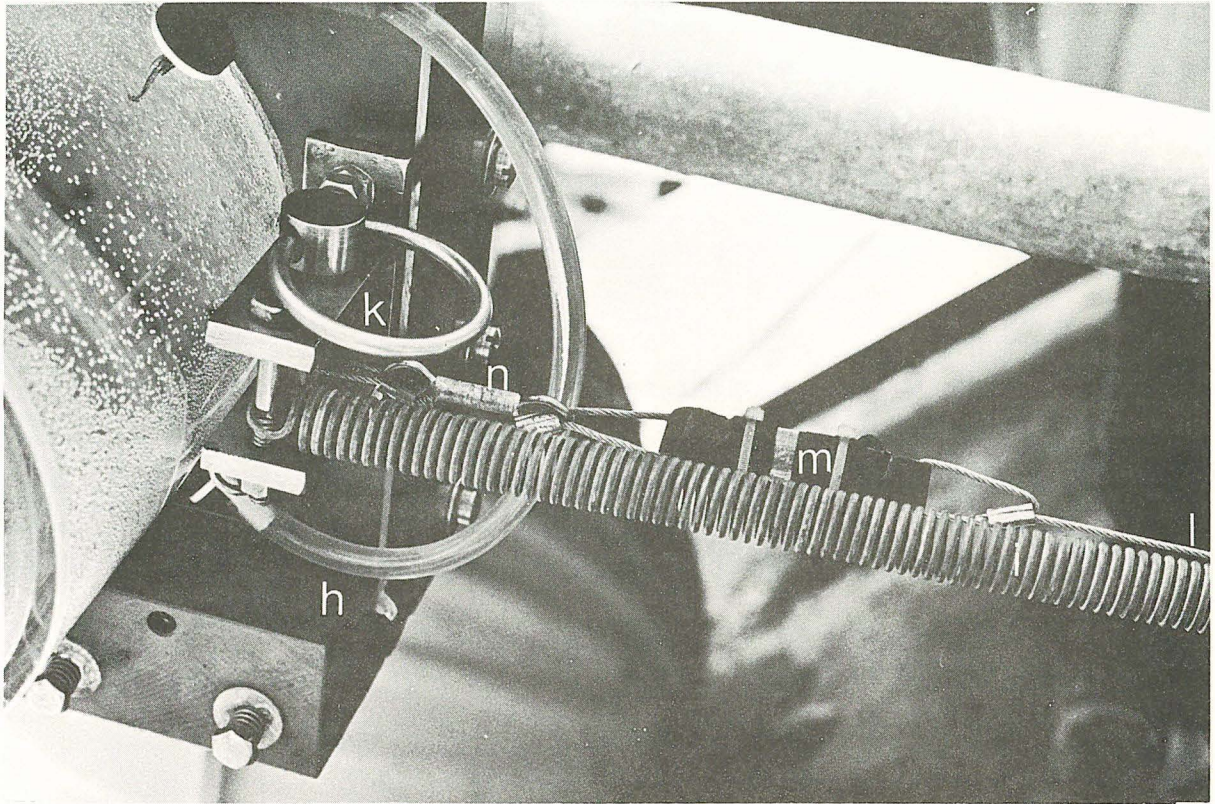
- A. A PARFLUX trap is affixed to a taut line with buoyancy spheres (b). Traps can be deployed through A-frame (a) or a crane.
- B. An upper tautline (t) should create a moderate pulling strength of a few hundred pounds during deployment. A trap is lifted from the deck via a set of side lines (c).
- C. Remote control latch (e) is released at the moment when the upper part of the trap starts to be submerged.
- D. A trap is now deployed in the water and is semi-submerged showing honeycomb buffer (h) and stay surface till an anchor starts to settle.
- E. Partial view of type C receiving cup. j. shutter, g. receiving cup (no bacteriacide chamber is seen in this photo); f. aluminum frame; and k. a fixture.
- F. A timer release is mounted on an aluminum plate which is welded on a frame. Two insulated wires (w) feed electricity to a burnwire loop via timer electronics.
- G. Photograph of burnwire-side of type C receiving cup mechanism. v. Titanium burnwire; r. turnbuckle covered with black tape to prevent spontaneous turn.

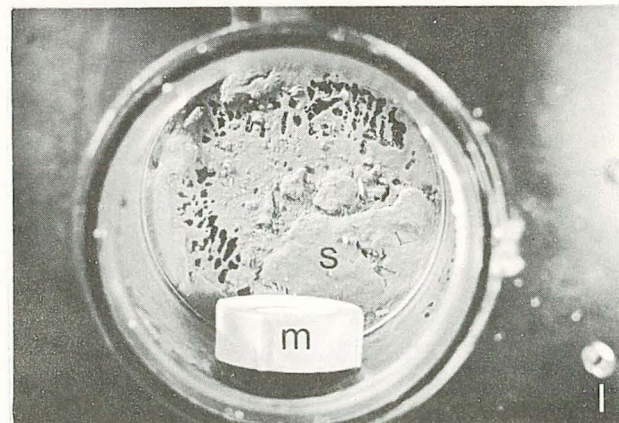
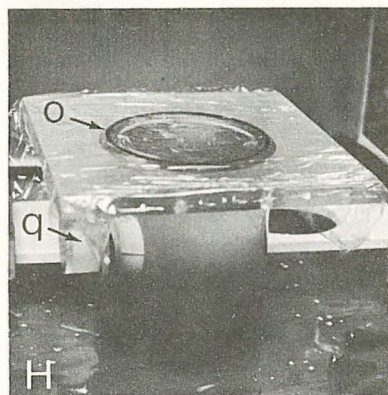
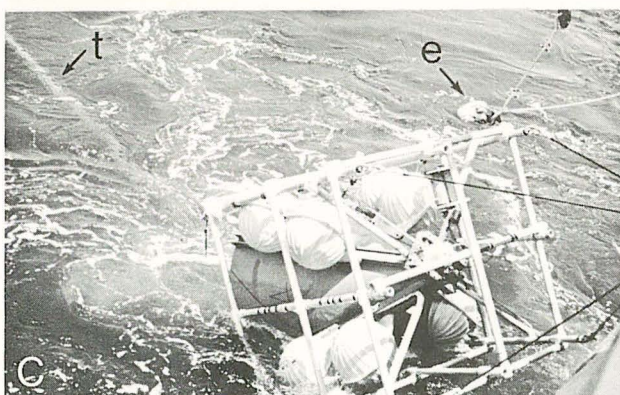
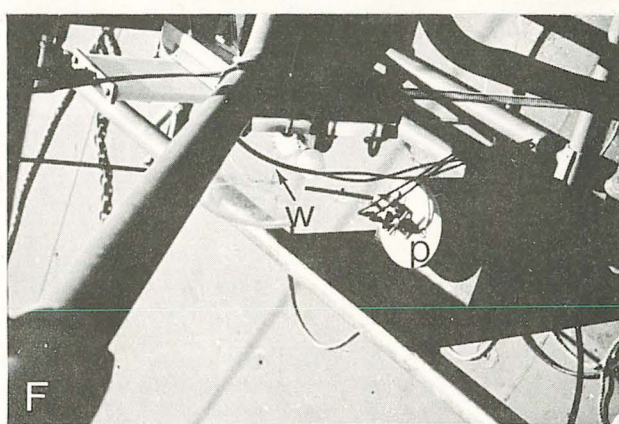
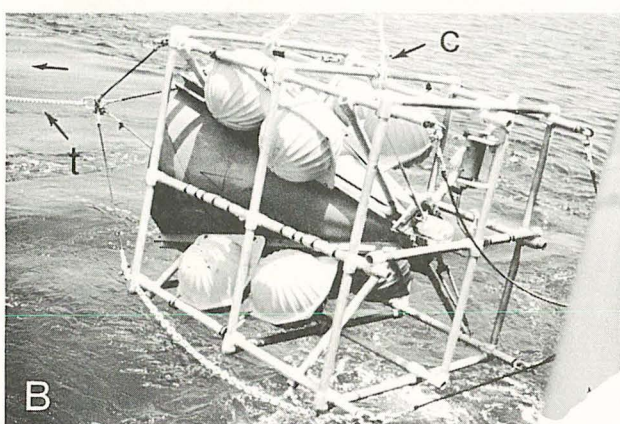
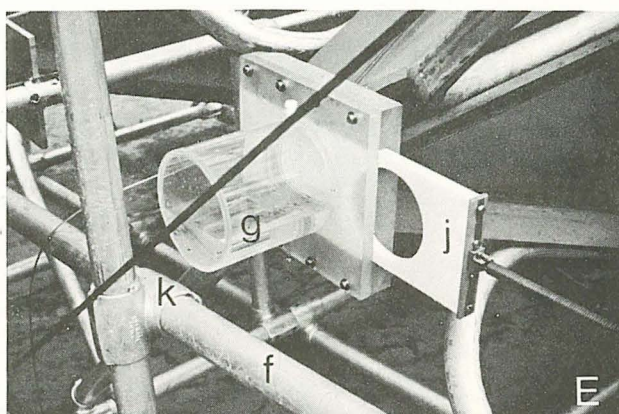
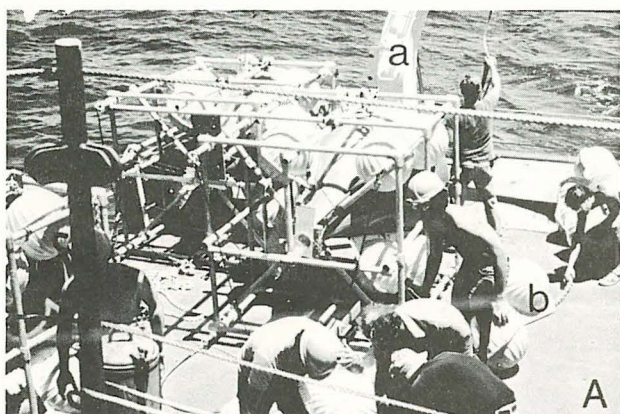
- H. Recovered sediment in type C receiving cup before covered with a PVC protective lid. C. Quad-X^R sealing ring; q. bacteriacide chamber.
- I. A photograph viewing inside of a receiving cup after recovery. m. filter holder of bacteriacides chamber; s. collected sample.

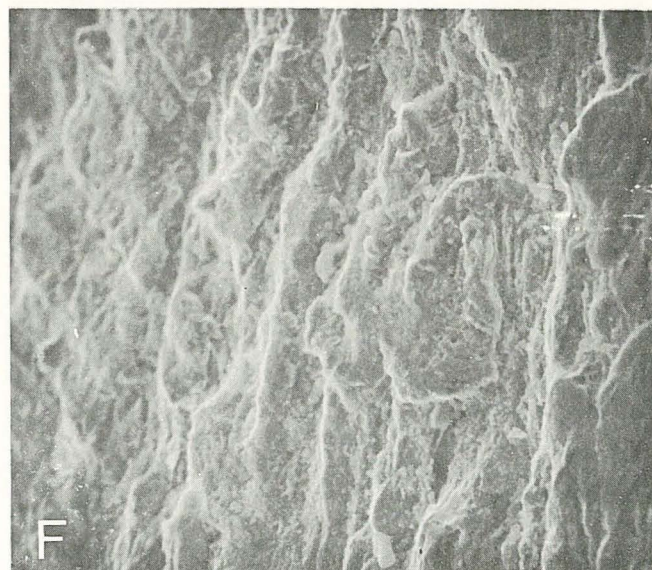
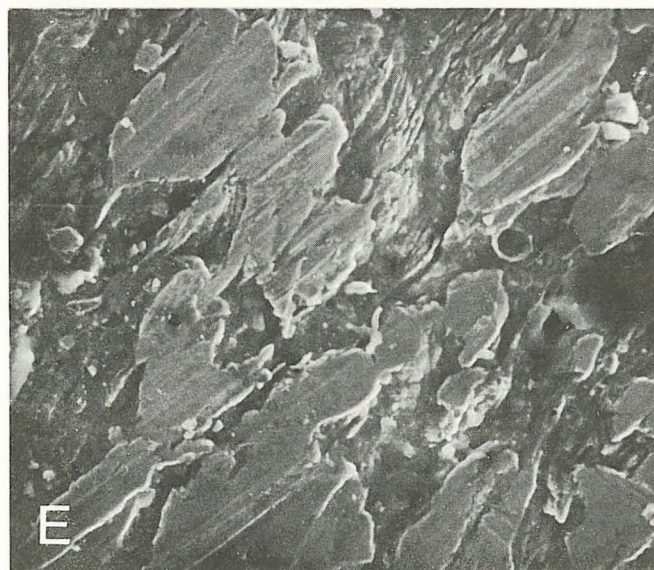
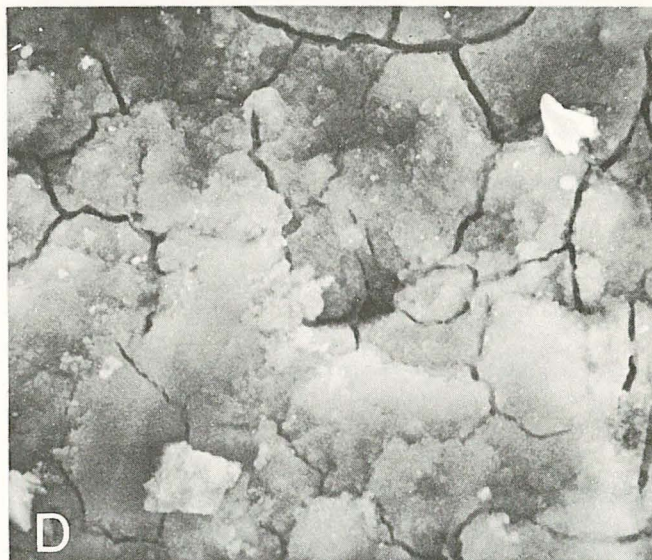
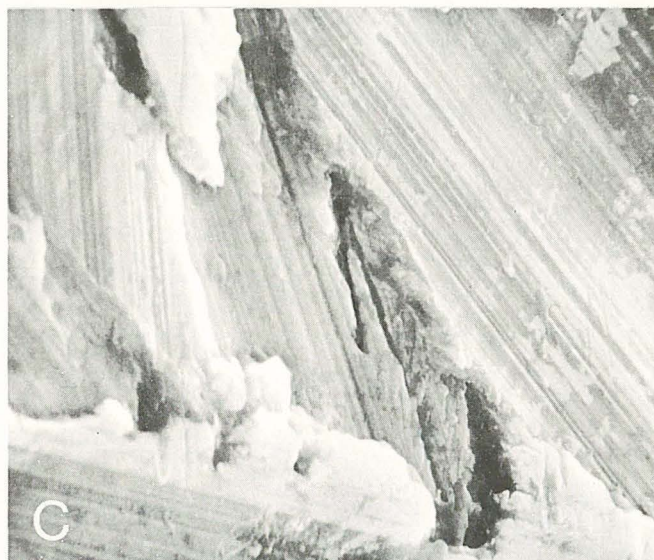
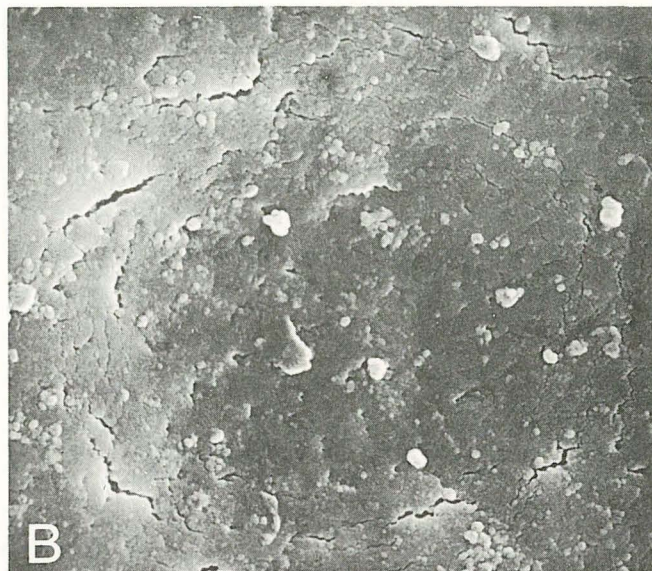
Plate 4.

- A. Fresh surface of polyvinyl chloride (PVC; Trovidour^R) under SEM. X 10,000.
- B. Same as A after 283 (accumulative) days of deployment along with the S₂ and E arrays. Essentially the surface is intact. Small white spots are possibly sea-salt. X 10,000.
- C. Fresh surface of type 600 (marine grade) aluminum. After X 500.
- D. After a long deployment, the thin veneer of surface was covered by dehydrated film. No structural weakness or fatigue was observed on the aluminum frames up to 344 accumulative days of deployment at 400 m or bathypelagic water. X 500.
- E. Fresh surface of type 360 stainless steel. Surface of a cold milled, v₂ bolt. X 800.
- F. Same material as E. After 344 days of accumulative deployment at bathypelagic layer.









APPENDIX 1

Sodium Azide, a hazardous compound

Sodium azide (NaN_3) is a powerful enzyme inhibitor (Fe^{+++} protoporphyrin enzymes) (e.g. White et al., 1968, Principles of Biochemistry, p. 239). It is generally recognized that the water/sea-water solution with 0.01% sodium azide inhibits microbial growth. It has been clear that sodium azide is hazardous in terms of strong toxication to the human body as well as it forms a detonating compound meeting with common metals such as copper and lead. A few hundred grams of undiluted sodium azide is used for a bacteriocide diffusion chamber for each deployment of a PARFLUX sediment trap. We feel it is important that sodium azide be used properly in preventing possible accidents.

There are three causes of hazard in the use of sodium azide: 1) toxicity to the human body by direct contact or acidified gas; 2) contamination of sewage water may stop the microbial degradation of waste in the system; and 3) formation of explosive matter by aquatic or non-aquatic contact with certain metals. We propose that sodium azide should, regardless of the amount to be used, be treated with extreme caution particularly on board a research vessel.

1. Sodium azide is assigned as a type B hazardous matter. Transport and storage of this material should be rendered in accordance with the regulations imposed by the Department of Transportation.
2. Report to the chief scientist the possession of sodium azide. Storage in laboratory; never leave outside of the scientific area.
3. Well protect the bottle and clearly label it. Any possibility of spillage of powder should be avoided. If it is diluted, clearly describe the percentage.
4. Be extremely careful to avoid direct contact with skin. Avoid any possible inhalation of undiluted powder.
5. Avoid on-board exposure of undiluted sodium azide as much as possible. If necessary, work on 4 mil. plastic sheet, at least 3'x4', spread on a bench as far from the ventilation registers as possible. When a job is completed, the plastic sheet should be folded carefully and sealed in a small plastic bag and bring for on-shore incineration. Do not contaminate door knobs, etc., with your hand. Take a shower as soon as possible after handling it.

6. Do not drain the solution at any dilution into the ship's or laboratory's sink. Do not contaminate the biogenic sewage system.
7. Regardless of the amount of dilution, avoid any possible contact with any kind of acid solution. Keep away from lead acid batteries.

The following is a partial citation from: Fire Protection Guide on Hazardous Materials, p. 491M-377, 7th ed. (1978), National Fire Protection Association, 470 Atlantic Avenue, Boston, MA 02210.

SODIUM AZIDE (NaN₃)

(self-reactive) Sodium azide decomposes at 275°C.

Mellor 8, supp. 2: 43 (1967)

- | | |
|--|---|
| Benzoyl Chloride and Potassium Hydroxide | The mixture of sodium azide and benzoyl chloride reacts spontaneously with evolution of heat in a potassium hydroxide solution. <u>Mellor 8, Supp. 2: 55 (1967).</u> |
| Chomyl Chloride | The reaction of sodium azide and chomyl chloride is an explosive one. <u>Mellor 8, Supp. 2: 36 (1967).</u> |
| Copper | A solution of sodium azide in copper pipe with lead joints formed copper azide and lead azide, both <u>detonating compounds. Klotz (1973).</u> |
| Dibromomalononitrile | These materials react to produce a product that is extremely sensitive to light shock. <u>MCA Case History 820 (1962). ASES</u>
<u>Expl. Report 89 (1962).</u> |
| Dimethyl Sulfate | During preparation of methyl azide from reaction of these two chemicals, a violent explosion occurred. Apparently the pH was allowed to fall below 5. At this activity hydrazoid acid, a powerful explosive, readily forms. <u>MCA Case History 887 (1963).</u> |
| Lead | See SODIUM AZIDE plus Copper. |
| Nitric Acid | The reaction of sodium azide and strong nitric acid is energetic. <u>Mellor 8, Supp. 2: 315 (1967).</u> |

Citation from: Clinical Toxicology of Commercial Products. 3rd ed., 1969 (Gleason, M.N., Gosselin, R.E., Hodge, H.C. and Smith, R.P.). The Williams & Wilkins Co., Baltimore.

AZIDE SALTS Induced methemoglobinemia affords
Sodium azide limited protection to animals

Hydrazoid acid acutely poisoned by azide. Since no other specific antagonists are presently recognized, a clinical trial is perhaps justified in a severe systematic intoxication. If so, proceed at once with the measures under CYANIDE in Section II, omitting only the thiosulfate injections.

Hydrazoic acid is used in industry to prepare heavy metal azides for shell detonators. The water soluble salts are not nearly so explosive. Workers exposed to this volatile acid for 15 yrs. showed no pathological signs. The vapors and fumes, however, are irritants of mucous membranes and heavy exposure has caused bronchitis and pulmonary edema. The azide ion is recognized as an inhibitor of heme iron enzymes, notably cytochrome oxidase, catalase and peroxidase. As with cyanamide, the chief danger in acute exposures is probably a fulminating histotoxic anoxia. Azide stimulates the chemoreceptors of the carotid body. It is even more potent than sodium nitrite as a directly acting peripheral vasodilator which may complicate attempts to antidote azide intoxication by nitrite. (See also: CYANIDE and HYDROGEN SULFIDE. Reference Congeners in Section III.) Ref.: Abbanat and Smith, 1964; Graham et al., 1948; Graham, 1949.

Partial citation from: Summary Report, ASCP Commission on Continuing Education, 2100 West Harrison Street, Chicago, Illinois 60612.

Explosion Hazard - A Solution by C. Broadbridge, B.C.R. Lowes, Springfield Hospital Center, Springfield, Massachusetts 01107.

"We wish to make everyone aware of a potential laboratory hazard that exists with some laboratory reagents containing sodium azide.

This particular chemical is commonly employed in saline and other isotonic solutions employed with automatic cell counters, as a preservative agent. The diluting fluids used with automatic counters and cell washers contain 0.01% sodium azide and due to the large quantities of diluent used, the effluent is usually discharged in a sink. Most sinks have copper or lead piping and the azide can form a very explosive compound with these metals. The problem arises when a blockage occurs and an attempt is made to remove it with a metal plumber's "snake". Four instances of explosions have been reported and fortunately, no injuries have occurred, but obviously a real hazard exists.

We would recommend the following procedure for all laboratories allowing sodium azide to be discharged through copper or lead pipes. Decontaminate the piping with nitrous acid after flushing with copious amounts of water. Replace all copper and lead plumbing with plastic pipeware. The old metal pipes should be cut away with pipe cutters and no attempt should be made to undo the joints."

Azide and Acid - Dangerous Mixture by E.L. Cohen, Presbyterian University of Pennsylvania Medical Center, Philadelphia, Pennsylvania, 19104, April 1974.

"The January 1974 issue of Summary Report carries on page one a note on the explosion hazard which can result from disposing of solutions containing sodium azide via lead or copper waste lines. The note recommends decontamination of piping with nitrous acid.

Immediate attention of all laboratories should be called to the health hazard of azide compounds before too much acid treatment is used.

In addition to their instability and explosive nature, azide compounds under acid conditions yield hydrazoic acid. This latter compound is extremely toxic, producing vertigo, weakness and dangerous falls in blood pressure. Sodium azide has been used as a hypertensive, but its effect has been highly uncontrollable. While the azide content of our solutions is low (usually 0.01% or less), where build-up has taken place, large quantities can be present.

I believe that no acid should be used to decontaminate piping, and that azide compounds should not be allowed to contact acid conditions. The safest method of disposing of solutions containing azides is by high dilution with water before discharge to waste. The sink in which we dispose of such solutions has had the water tap washer cut so that the water flow can never be cut off. Under such conditions we have seen no build up of azides in piping.

My concern with and respect for azide compounds was learned personally the hard way, and the experience was not pleasant. At a minimum all persons using these compounds should carefully read the warnings required by law on the containers."

APPENDIX 2.

Electronics Timer Release

The following information on BENTHOS 855-2 Deep Sea Light Load Timed Release was provided us by Mr. David Hosom, Benthos, Inc., North Falmouth, Mass., as was cited as "personal communication, publication by permission". We have also successfully used the OIS-Williams release as well.

Theory of Operation

This description refers to the block diagram in Appendix 2. In this circuit a crystal oscillator provides a frequency of 32,768 Hz. Internal to the chip, the frequency is divided by 2^{15} (with the jumper in X1 position) to obtain an accurate 1 Hz output. (When the jumper is moved to the X2 position, the frequency is divided by 2^{16} giving a 0.5 Hz output, thus doubling the delay time.) The 1 Hz output is fed into the first divide by 60, resulting in an output of 1 pulse every minute. The output of this is in turn fed into the second divide by 60, giving an output of 1 pulse every hour.

For testing, the test switch S2 bypasses both the divides delivering a 1 Hz output in place of the 1 pulse per hour output. When the jumper is moved to the "minutes" position, only the second divide is bypassed, resulting in a final output of 1 pulse per minute for higher resolution, short term deployments. The output signal is fed into the first of the four decade counters. The four counters form a unit capable of counting from 0000 to 9999. The four rotary switches for each decade determine where along this counting progression a release will be initiated.

When all the counters have reached their appropriate counts, the four inputs of the AND gate will be at a logic one state. When this signal goes high, the transistor turns on, supplying gate current for the silicon controlled rectifier which also turns on, grounding the housing, supplying a ground path by which the release wire begins to dissolve. In addition, the logic 1 output from this gate causes the oscillator and the first counter to be disabled, preventing any further counting from taking place, and ensuring that, once timed out, the output will remain high.

Specifications

Time delay adjustment: Settable on any hour from 0 to 9,999 hours (416 days) or from 0 to 19,998 hours (832 days). Jumper provides minutes instead of hours delay if desired.

Timing Accuracy: $\pm 0.01\%$ (or better) of set delay (1 part in 8,000).

Batteries: 24 separate batteries for high reliability; 9 volt alkaline (Mallory MN1604 Duracell).

Test Circuit: Built-in. Allows times to be cycled at a 1Hz rate.

End Cap Connector: Joy #X8372-103.

Connector Cable: Joy #X8372-153.

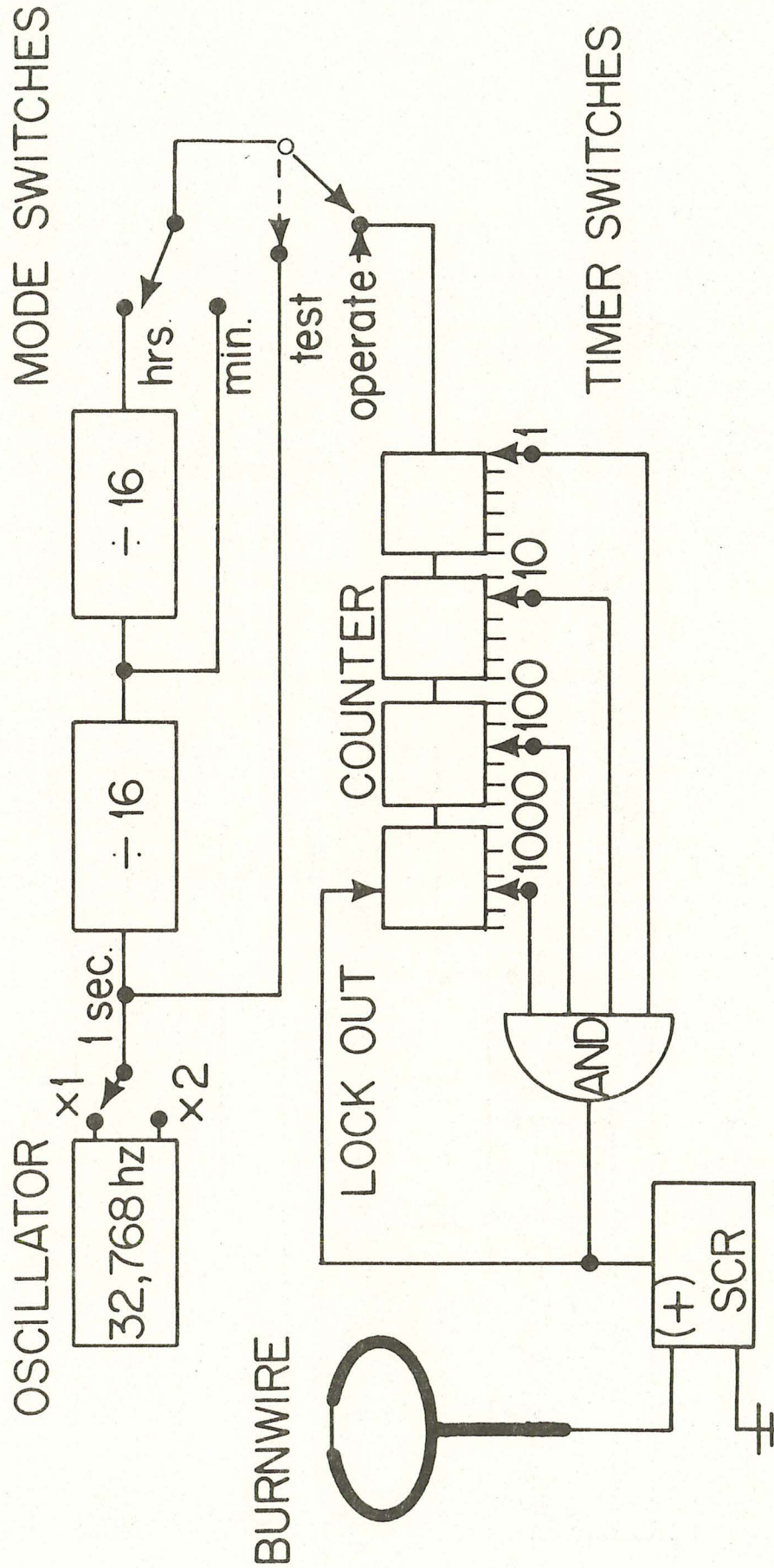
Release Loop Material: 6Al-4V titanium wire.

Housing Material: Hardened 17-4PH stainless steel.

Depth Rating: 12,000 meters.

Dimensions: 12.2 cm (4.8 inches) diameter by 32.7 cm (12 7/8 inc.)

Weight: 14.1 kg (31 pounds).



App. Figure 1.

BIBLIOGRAPHIC DATA SHEET		1. Report No. WHOI-79-80	2.	3. Recipient's Accession No.
4. Title and Subtitle CONSTRUCTION OF PARFLUX MARK II SEDIMENT TRAP; ENGINEERING REPORT			5. Report Date November 1979	
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9. Performing Organization Name and Address Woods Hole Oceanographic Institution Woods Hole, MA 02543			10. Project/Task/Work Unit No.	
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15. Supplementary Notes				
16. Abstracts In order to assess the fluxes of particles sinking through the deep water column a large, open ocean applicable sediment trap has been developed, under the sponsorship of the National Science Foundation. The trap opening is 1.5 m ² and consists of 94 hexagonal buffer cells with the nominal form ratio of 2. Sediment particles are concentrated to the receiving cup located at the bottom of the funnel-shaped trap. Two types of receiving cups have been developed; a trap with Type S cup is open at both ends as it sinks to the designated depth. The receiving cup moves into alignment with the funnel automatically to store the sediment. At the end of deployment, an electrical signal moves the receiving cup again to seal the collected sample and leave the funnel open at both ends while the trap is recovered. Type C mechanism is installed with a shutter which seals the cup during recovery; it involves a simple mechanism. Sodium azide/sodium chloride solution is diffused through a series of membrane filters to keep the cup contents in an aseptic (Cont.***)				
17. Key Words and Document Analysis. 17a. Descriptors 1. Sediment trap 2. Deep water column 3. Flux of sediment *** condition. We have deployed and recovered 18 traps successfully along with several moorings as deep as 5,600 m for as long as 110 days. This reports the engineering detail, parts list and illustrates the PARFLUX sediment trap.				
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17c. COSATI Field/Group				
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